MINERAL DEVELOPMENT DIVISION
DEPARTMENT OF MINES AND ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

PRELIMINARY CURRENT RESEARCH REPORTS

St. John's, Newfoundland
1983

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November, 1983

ADDITION TO PAPER BY O'BRIEN AND TOMLIN

The anomalous radioactivity reported on pages 79 and 81 of this volume was measured with a SCINTREX BGS-1 scintillometer (see O'Brien and Tomlin, page 78).

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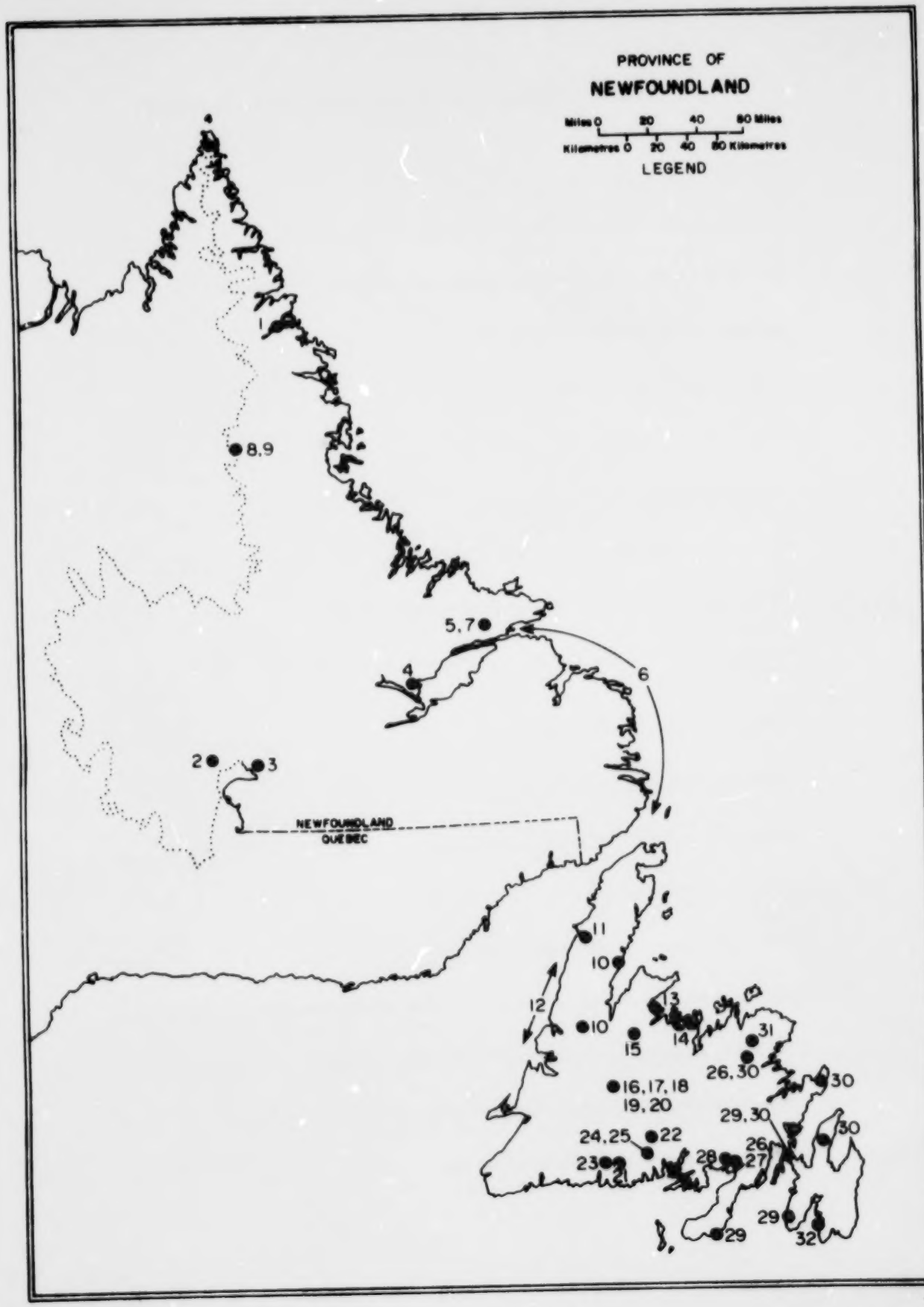

PROVINCE OF
NEWFOUNDLAND
Miles 0 20 40 60 Miles
Kilometres 0 20 40 60 Kilometres
LEGEND
1
8,9
5,7
6
4
2
3
NEWFOUNDLAND
QUEBEC
11
10
12
10
13
14
15
31
26,30
30
16,17,18
19,20
29,30
24,25
22
30
26
23
28
27
29
29
32

LIST OF SYMBOLS USED ON GEOLOGICAL MAPS AND FIGURES

Drift covered area

Rock outcrop, area of outcrop, probable outcrop, float, frost-heaved rock

Geological boundary (defined, approximate, assumed, gradational, dip indicated)

Intrusive contact with younger unit indicated

Unconformity (defined, assumed)

Limit of geological mapping

Limit of area surveyed with aircraft

Bedding, tops known (horizontal, inclined, vertical, overturned)

Bedding, tops unknown (horizontal, inclined, vertical, dip unknown)

Bedding, general trend (dip unknown, top unknown; dip and top known; dip known, top unknown)

Bedding, estimated dip (gentle, moderate, steep)

Igneous flow banding (inclined, vertical)

Igneous intrusive sheets (inclined, vertical)

Primary igneous layering, tops known (horizontal, inclined, vertical, overturned)

Primary igneous layering, tops unknown (horizontal, inclined, vertical)

Strike and dip of pillows, tops known (horizontal, inclined, vertical, overturned)

Strike and dip of pillows, tops unknown (horizontal, inclined, vertical)

Primary igneous mineral lamination (inclined, vertical)

Primary igneous mineral lineation (inclined, vertical)

Flow Contact

Zone containing xenoliths

Zone of intrusive agmatite

Roof pendant (unit number indicated; too small to map separately)

Zone containing autoliths

Breccia of various origins

Slaty cleavage (horizontal, inclined, vertical, dip unknown)

Strain-slip cleavage (horizontal, inclined, vertical, dip unknown)

Schistosity, cleavage, foliation; used where ages of foliation are indicated on the map (horizontal, inclined, vertical)

Schistosity of unknown age

S_1

S_2

Schistosity, gneissosity, cleavage, foliation, general trend

Gneissic foliation (horizontal, inclined, vertical, dip unknown)

Gneissic banding (horizontal, inclined, vertical)

Axial plane of minor fold (inclined, vertical, dip unknown)

Lineation (horizontal, inclined, inclined but plunge unknown, vertical)

Type of lineation denoted by letter:

Mineral lineation M

S intersections S

Microcrenulations C

Boudin axes B

Deformed clasts D

Igneous inclusions I

Rodding, mullion structure R

Metamorphic aggregates A

Deformed pillows P

Age of lineation and of minor fold axes

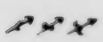
Lineation of unknown age

L_1

L_2

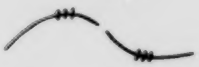
Axes of minor folds (horizontal, inclined, vertical)

Sense of vergence of minor structures (used with minor fold axes symbol or lineation S intersection symbol; read looking along the arrow)

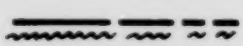


Structural trend (from aerial photographs)

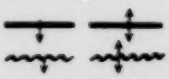
Lineament (from aerial photographs)



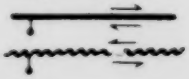
Fault (defined, approximate, assumed)



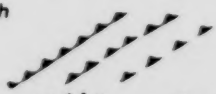
Fault (inclined, vertical)



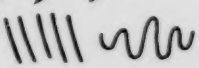
Fault (solid circle indicates downthrown side, arrows indicate relative movement)



Thrust fault (teeth in direction of dip, defined, approximate, assumed) (teeth indicate upthrust side)



Zone of numerous imbricate thrust faults

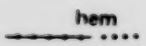


Fault zone, shear zone (width indicated)

Tectonic slide

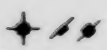
Vein fault (defined, assumed)

Mineralized bed or seam (hematite)

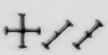


Dike, vein, or stockwork (defined, approximate, assumed; unit number and dip indicated)

Joint (horizontal, inclined, vertical)



Sheeted dikes (horizontal, inclined, vertical)



Anticline (defined, approximate, assumed)

Antiform

Syncline (defined, approximate, assumed)

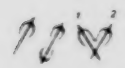
Synform

Anticline and syncline (overturned)

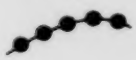
Anticline or syncline (arrow indicates plunge)

Antiform or synform

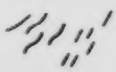
Glacial striae (direction of ice movement known, unknown). Numbers indicate relative age, 1 being the oldest



End moraine



Minor moraines, rib moraines, washboard moraines, "annual" moraines, till ridges transverse to ice flow (irregular, straight)



Drumlins, drumlinoid ridges (direction of ice movement known, unknown)

Crag and tail hills and ramps

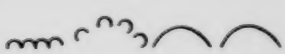
Glacial linear feature

Pingo or palsen

Esker (direction of flow known, unknown)

Esker (continuous, discontinuous)

Raised beaches

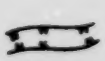


Limit of marine or lacustrine submergence (well marked, assumed)

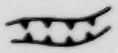
Dunes

Area of sand dunes

Buried valley

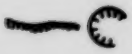


Abandoned river channel, spillway, ice-marginal channels, rill patterns, etc.



Landslide scar

Escarpment and cirques



Fossil locality

Locality where age has been determined, in millions of years

Ice divide

Land system boundary

Location of measured section

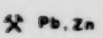
Gravel pit or quarry (active, abandoned)

Borrow pit (active, abandoned)

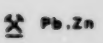
Rock dump or tailings

Rock quarry (active, abandoned)

Mine (lead, zinc)



Mine (lead, zinc; abandoned)



Mineral prospect; mineral occurrence (manganese)

Placer deposit (gold)

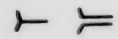
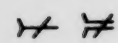
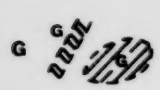
Show of oil and gas (abandoned)

Show of gas(abandoned)

Gas producer

Oil producer

Oil and gas producer

Location of drilling	
Dry (abandoned)	
Water source or disposal	
Shearing and dip	
Salt spring	
Hot spring	
Mineral isograd	
Other alternatives when more than one	
Shaft, raise, winze	
Shaft (abandoned)	
Trench	
Open cut; axial	
Adit or tunnel	
Adit or tunnel (caved)	
Borehole	
Diamond drill hole	
(Surface projection of geology inferred)	
Sinkhole	
Gossan	
Trace of coal seam	

ADDITIONAL SYMBOLS

Geological boundary (geophysically defined) . . . . . .

Geophysical conductor . . . . . .

Roche moutonnee . . . . . .

Meltwater channel . . . . . .

Sinkhole . . . . . SH

Open pit, mine or quarry . . . . . .

Locality where age has been determined, in thousands of years before the present . . . . . Ⓕ^{125}

Till fabric (direction known, unknown, known plus cross fabric) . . . . . .

SAMPLE LOCALITIES (SURFICIAL)

Glacial till . . . . . ●

Gravel . . . . . ⊗

Sand . . . . . ○

Silt . . . . . ■

Clay . . . . . +

Organic . . . . . ✸

Rock . . . . . Ⓡ

Pleistocene fossil . . . . . Ⓕ

Labrador

THE NAIN - CHURCHILL BOUNDARY IN THE HEBRON AREA OF NORTHERN LABRADOR: SUMMARY REPORT

by

Bruce Kyan
Labrador Mapping Section

The 1983 season was the second of a two-year program to conduct 1:100,000 scale geological mapping and mineral potential evaluation of the Precambrian rocks of northern Labrador. The survey concentrated chiefly on the Hebron Fiord area this year (NTS sheets 14L/2,3; Figure 1), and a preliminary report on the results is in preparation.

Highlights of the 1983 study include:

(1) In contrast to the Saglek area where the easternmost Nain Province is at amphibolite facies, the whole of the Hebron area exhibits a 2.8 Ga migmatization and granulite facies overprint which has been subsequently retrogressed. Only small enclaves of the 3.6 Ga Uivak gneisses have escaped this reworking.

(2) Metasedimentary rocks comprise a greater percentage of the Archean terrane at Hebron than at Saglek. Some of these belts are up to 1.5 km wide and continuous along strike for 5 km.

(3) The Ramah Group supracrustal rocks which occupy the eastern foreland zone of the Hudsonian Churchill Orogenic Belt are excised north of Hebron Fiord and granulite facies gneisses of the Churchill Province abut granulite facies gneisses of the Nain Province. The contact zone is marked by a pronounced zone of pseudotachylite and ultramylonite. The hypersthene gneisses of the Churchill are Proterozoic reworked equivalents of those in the Nain to the east.

In addition to the work in the Hebron area, detailed work of the Saglek Fiord area and eastern coastal strip by visiting scientists from Denmark and Australia involves ongoing petrological and isotopic studies of the lithological variations in the Nulliak assemblage (a pre-3.6 Ga supracrustal succession), of the younger migmatites and granites (2.7 to 2.5 Ga), and of a series of gneisses which may predate the Nulliak supracrustals. Also, detailed stratigraphic and structural studies have begun on the Ramah Group by a Ph.D. student at Memorial University.

In spite of scintillometer surveys and limited ultraviolet light investigation, no radioactivity nor scheelite mineralization was detected. Pyritic zones are locally present in the metasediments, and graphite seams occur in granulite facies rocks in the Churchill Province, but none are of economic importance.

Contribution to the Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Geological Survey of Canada.

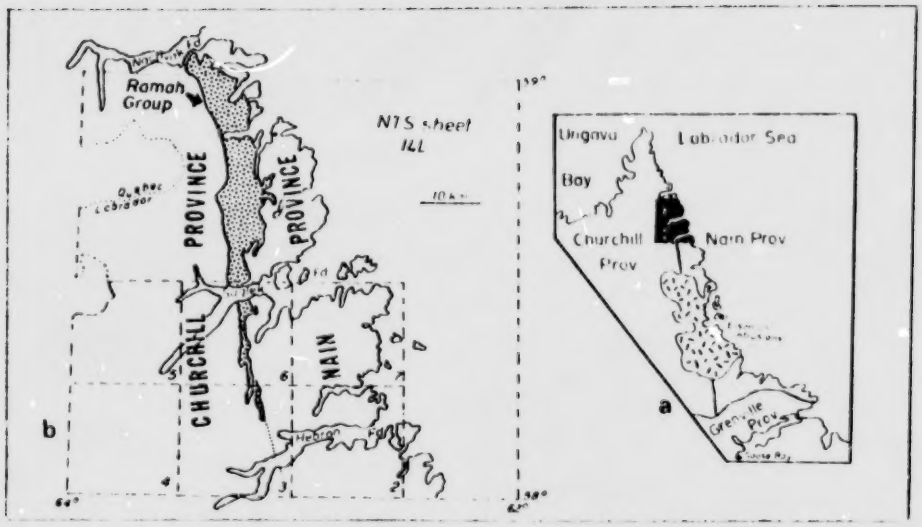


Figure 1: *(a) location of NTS sheet 14L in northern Labrador; (b) sketch map of Saglek - Hebron area. NTS 14L/6,7 was completed in 1982; 14L/2,3 was mapped during 1983 season.*

ATIKONAK RIVER PROJECT, GRENVILLE PROVINCE, LABRADOR

by

G.A.G. Nunn, N. Noel[1] and N.G. Culshaw[2]
Labrador Mapping Section

N.T.S. map sheets 23A/9, 10, 15 and 16 comprised this season's mapping which was centered around Atikonak Lake in southwestern Labrador.

The following sequence of events is proposed for the map area.

Orogeny	Grenville	ca. 1000 Ma
Anorthosite and related rocks		
Orogeny		ca. 1650 Ma
Plutonic granitoid suite		?ca. 1660 Ma
Gabbro to norite suite		
Orogeny	probably Hudsonian	ca. 1800 Ma
Supracrustal sequence		? Aphebian

The supracrustal rocks predominantly consist of semipelitic paragneisses with rare psammitic layers. Intercalated with these, particularly in western areas, are basic gneiss units with tonalitic sheets and minor quartzite. These are believed to represent a graywacke - basic volcanic - quartzite association, and the whole package is similar to parts of the Labrador Trough succession.

The earliest orogeny to affect these rocks resulted in polydeformed migmatites, probably of a sillimanite-bearing facies, that, by extrapolation to regions outside this map area, ranged from upper amphibolite to granulite metamorphic grades. The tonalitic sheets associated with the basic gneisses probably relate to this time. In the northeast of the map area, a structurally complex granulite facies block with very variable trends of the gneissosity has remained relatively unchanged since the close of the orogeny.

The gabbro to norite suite is composed of isotropic to foliated, homogeneous to seriate textured plutons. Relict layering is very rare and the seriate textures may be primary or metamorphic. This suite is no longer correlated with the Shabogamo Intrusive Suite of western Labrador.

The plutonic granitoid rocks are mostly K-feldspar megacrystic, foliated granodiorite to quartz monzonite. Foliated to gneissic equigranular rock types are also present.

Contribution to the Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Geological Survey of Canada.

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The presence of an orogeny at about 1650 Ma is based on U-Pb zircon ages from adjacent areas to the north (personal communication, T. Krogh, 1983). This major polydeformational tectonothermal event produced high grade migmatites in this part of Labrador. During the orogeny the main ductile mineral recrystallization occurred at granulite grade in rocks now underlying the northwest and east parts of the map area and at upper amphibolite grade throughout the remaining area. In the east, granulite grade mineral assemblages may, wholly or in part, be due to relict Hudsonian and igneous mineral facies. Relict mineral assemblages in parts of the amphibolite grade areas suggest that granulite facies conditions were more extensive earlier in the orogeny. Later events in the orogeny consist of thrusting of granulite facies over amphibolite facies rocks and a conical folding of this and earlier structures to produce the regionally dominant north trending strikes of the western and central portions of the map area. All these structures were previously assigned to the Grenville Orogeny.

The southeast of the map area is underlain by anorthosite, leucogabbro and leucotroctolite which represent the northern tip of a large anorthosite massif extending to the south. In this area, noritic rocks may be associated with the anorthosites rather than the gabbro to norite suite.

Lead loss results from north of the area show that during the Grenville Orogeny temperatures did not exceed the blocking temperature for sphene (approximately lower amphibolite facies) for long enough to completely reset the system (personal communication, T. Krogh, 1983). Combined with the zircon ages on granulite grade rocks in the same area, these results indicate that the Paleohelikian, and not the Grenville, orogeny is the major gneiss-forming event in the area. Regionally the Grenville Front Tectonic Zone is here at least 130 km wide throughout which Grenvillian ductile deformation is still localized and occurs at grades of lower amphibolite facies or less. A major amphibolite facies shear zone occurs in the southeast corner of the area and cuts across the regional Paleohelikian trends with an east-northeast strike and a strong down-dip lineation moderately or steeply plunging toward the north-northwest. This wide zone may be the only significant ductile structure of Grenvillian age in the map area.

The intercalated metabasic volcanic rocks and paragneisses contain numerous rusty weathering zones whereas the paragneisses away from this association are not known to contain gossanous layers. Malachite showings are present in all the major rock types in the northwestern part of the map area and may be associated with north-south ductile structures or lineaments. The granitoid, gabbroid and paragneiss units are all rich in magnetite and poor in sulfides. No labradorite occurrences have been found in the anorthositic suite, but these rocks contain abundant magnetite and disseminated pyrite, and similar anorthosites in nearby Quebec are a major source of titanium.

GEOLOGY OF THE LAC GHYVELDE - LAC LOMG AREA, LABRADOR AND QUEBEC

by

A. Thomas, N. Culshaw[1], G. Mannard[2] and G. Whelan[3]
Labrador Mapping Section

The map area is located in west central Labrador between longitudes 63°00' to 64°00' west and latitudes 52°30' to 53°00' north. It is within the northern part of the Grenville structural province. Rocks within the area can be divided into six units.

Granulite grade tonalite to quartz tonalite (Unit 1) comprises approximately half of the exposure in highland terrain within the southern part of the area. The unit is massive to gneissic, tectonized and consists of quartz, plagioclase, orthoclase, orthopyroxene, clinopyroxene, biotite, magnetite, and lesser amounts of hornblende and ubiquitous garnet. Numerous deformed and boudined amphibolite dikes and xenoliths are present within the tonalite.

Banded, granulite to amphibolite grade quartzofeldspathic paragneiss (Unit 2) occurs within an open, mostly barren highland plateau covering the entire northern half of the map area. Granulite grade paragneiss is the predominant lithology, comprising plagioclase, orthoclase, quartz, sillimanite, hypersthene, magnetite and biotite. Patches of amphibolite grade paragneiss are rare in occurrence and are identified by lack of orthopyroxene as well as greater preponderance of biotite plus minor retrograde muscovite. Norite boudins and inclusions of various sizes occur rarely within the paragneiss. Rocks of this unit have been extensively deformed during a Paleohelikian orogenic event which has been dated at circa 1650 Ma.

Granitic to granodioritic orthogneiss (Unit 3) occurs in the southern highland terrain with the tonalite but in slightly greater abundance. Although rocks belonging to this unit are predominantly gneissose. variations from well banded orthogneiss through lineated and augen gneiss (after porphyritic granodiorite) to strongly foliated granitoid protolith can be observed. Orthogneiss consists of quartz, plagioclase, orthoclase, biotite, hornblende and garnet along with minor magnetite. It is intrusive into the tonalite (Unit 1) and may form a fault contact or faulted intrusive contact with the granulite paragneiss (Unit 2).

Unit 4 comprises an anorthosite-granitoid suite, the rocks of which are confined to the southwestern portion of the map area, along the southern edge of the northern plateau. Rocks of the suite can be divided into felsic and mafic varieties which define four subunits. Mangerite/jotunite is generally porphyritic in nature and comprises

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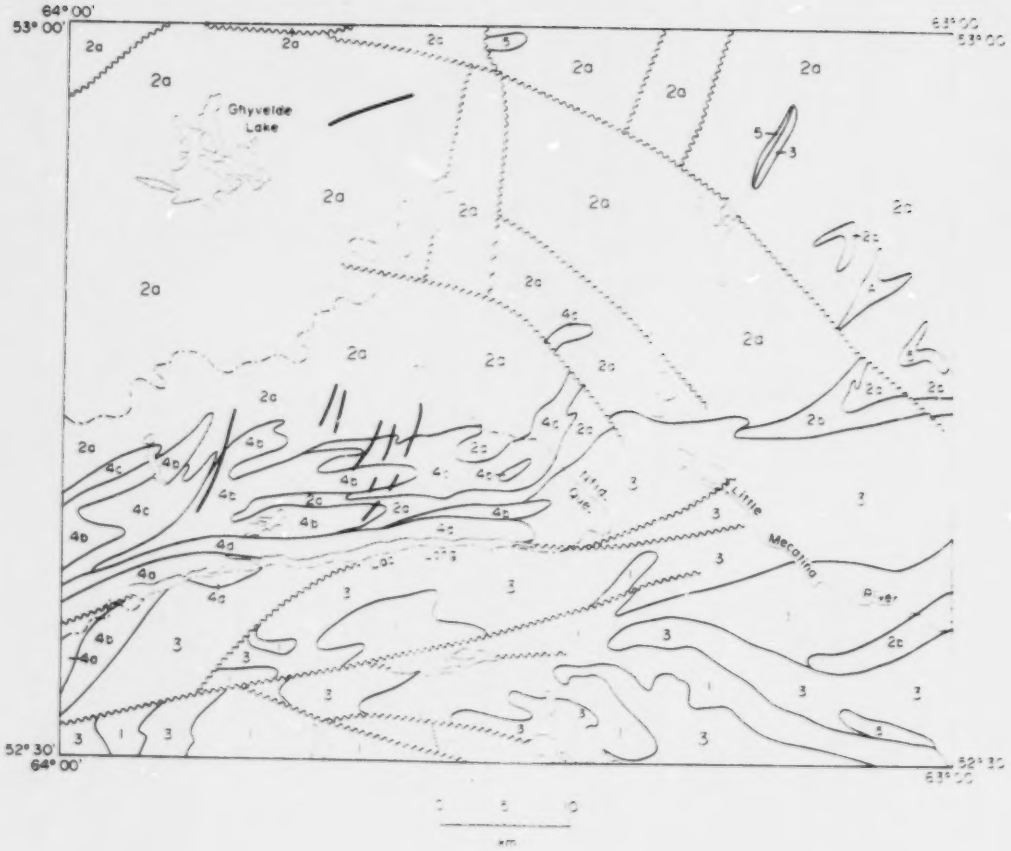

Figure 1: *Lac Ghyvelde – Lac Long area, Grenville Province, Labrador.*

LEGEND

NEOHELIKIAN(?)

Diabase(6)

5 Gabbro/norite

A Foliated diorite to quartz diorite of unknown affinity

PALEOHELIKIAN

4 Anorthosite Suite
- (a) Monzogabbro
- (b) Norite/gabbronorite
- (c) Charnockite
- (d) Mangerite/jotunite

3 Strongly foliated to gneissic granite to granodiorite

APHEBIAN (and earlier?)

2 Paragneiss
- (a) Granulite grade sillimanite-hypersthene- bearing
- (b) Aphibolite grade sillimanite-bearing

1 Gneissic to massive tonalite to quartz tonalite (granulite grade).

Fault (defined, assumed)

Newfoundland/Quebec border

plagioclase, orthoclase, orthopyroxene, clinopyroxene and magnetite-ilmenite. Garnet is present locally with minor biotite. Charnockite is similar in mineralogy but contains up to 12% free quartz. Monzogabbro is confined to the extreme southwestern portion of the map area and consists of plagioclase, orthopyroxene, clinopyroxene and magnetite-ilmenite with red-brown phenocrysts of K-feldspar (orthoclase?). Deformed pyroxene crystals up to 0.25 m length have been observed. Norite/gabbronorite occurs in contact with the monzogabbro. It has similar mineralogy but lacks K-feldspar phenocrysts and is a compositional variant of the monzogabbro. All rocks of the anorthosite suite have been moderately to strongly deformed into a narrow (8 km wide) east trending belt in the southwestern part of the map area. Igneous textures have for the most part been preserved and all rocks of the suite have intruded the older tonalite, paragneiss and orthogneiss units. The absolute age of the anorthosite is not known, but the suite probably belongs to one or the other of the 1600 or 1400 Ma anorthositic events recorded in Labrador.

Several small (less than 5 km) bodies of gabbro/norite (Unit 5) occur within the granulite paragneiss. These consist of plagioclase, orthopyroxene, clinopyroxene, magnetite-ilmenite, spinel and minor biotite and hornblende. At present, these bodies are thought to be older than and not related to rocks of the anorthosite suite.

A number of late, northeast trending diabase dikes (Unit 6) up to 50 m wide are also found within granulite paragneiss. These form a minor lithology at the scale of mapping, but are important from a geochronological aspect since they show little evidence of deformation and intrude other lithologies within the map area.

All rocks within the study area were tectonized during the Grenvillian Orogeny; however, the granulite paragneiss (Unit 2) acted as a rigid block, its structure reflecting a Paleohelikian deformational event. A series of east trending faults and shear zones which transect the map area is Grenvillian in age; northwest trending faults within the paragneiss are older. All units except the anorthosite suite show evidence of granulite to upper amphibolite metamorphic effects. The granulite grade event represented in the quartzofeldspathic paragneiss (Unit 2) is known to be Paleohelikian. That represented in the tonalite (Unit 1) may be Grenvillian or possibly pre-Paleohelikian in age.

GEOLOGY OF THE NORTH WEST RIVER AREA (13F/9), LABRADOR

by

R.J. Wardle

The map area is situated within the Grenville Structural Province of eastern Labrador, and connects previous mapping by Ryan et al. (1981, 1982) to the west, with that of Erdmer (1982) to the north.

The area is divisible into two major geological components: an old pre-Grenville (1000 Ma) gneiss terrane underlying the northeastern half of the area, and a younger complex termed the Cape Caribou River allochthon (Ryan et al., 1981) or nappe, comprising gabbro, anorthosite and amphibolite, which has been thrust north over the old gneiss terrane.

The oldest rocks in the pre-Grenville gneisses are kyanite-bearing metasedimentary gneisses (Unit 1) present as a narrow band north of Grand Lake. These are partly surrounded by an extensive suite of granitoid gneisses (Unit 2) composed largely of migmatitic granodiorite gneiss but containing significant quantities of pink granitic gneiss, and also a discreet unit of quartz diorite gneiss (Unit 2a) restricted to the north shore of Grand Lake. All granitoid gneiss types are characterized by abundant bands of amphibolite, locally recognizable as relict mafic dikes, and metagabbroic intrusions.

The granitoid and metasedimentary gneisses are believed to have been formed in a high grade metamorphic event circa 1650 Ma and to have suffered only moderate structural reworking during the Grenvillian Orogeny circa 1000 Ma. The metasedimentary gneisses of Unit 1 are correlated with the extensive Disappointment Lake gneiss of central Labrador, and are believed to have likewise been derived from an Aphebian protolith.

The granitoid gneisses were locally intruded by small bodies of granitoid (Units 3 and 4) which were emplaced post-tectonically with respect to the 1650 Ma event but prior to the Grenvillian Orogeny.

The Cape Caribou River nappe complex consists of a structurally lowermost unit of interlayered and strongly mylonitized garnetiferous amphibolite, mafic granulite (ortho and clinopyroxene bearing), leuco-amphibolite and white granite (Unit 5). This passes upward into massive to layered amphibolite and metagabbro (Unit 6a), interlayered gabbro and leucogabbro (Unit 6) and finally massive anorthosite (Unit 7). Contacts between these units are gradational.

The pre-Grenville gneisses (Units 1 and 2) are characterized by irregular gneissic trends with an overall northeasterly orientation. These have been locally straightened and mylonitized in a northeast trending, shallow dipping ductile shear zone, probably related to Grenvillian overthrusting within the granitoid gneisses. In the vicinity of Grand Lake the gneissic fabrics become reoriented into northwesterly structural

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Contribution to Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Newfoundland Department of Mines and Energy.

trends and are overprinted by shallow, south dipping mylonitic fabrics associated with development of a major ductile shear zone at the base of the Cape Caribou River nappe. Fabrics within the nappe trend parallel to those in the underlying shear zone.

The Cape Caribou River nappe as a whole has a horseshoe or lobate outline, only the eastern part of which is seen in the map area. This structure measures 26 km across in a northeast-southwest direction. Consistent southeast plunging lineation directions within the nappe and the ductile shear zone indicate that the thrust direction was to the northwest. This presumably occurred during the Grenvillian Orogeny.

The map area contains only minor showings of mineralization. Pegmatites within the metasedimentary gneisses of Unit 1 locally contain between 15 and 25% of a gray metallic mineral tentatively identified as ilmenite. Ilmenite also occurs as small crystalline segregations within the anorthosite of Unit 7.

Small fluorite showings have also been found associated with thin, sheared granite veins within the anorthosite.

In its more massive internal zone, the anorthosite also locally contains iridescent labradorite which may have commercial potential as facing stone.

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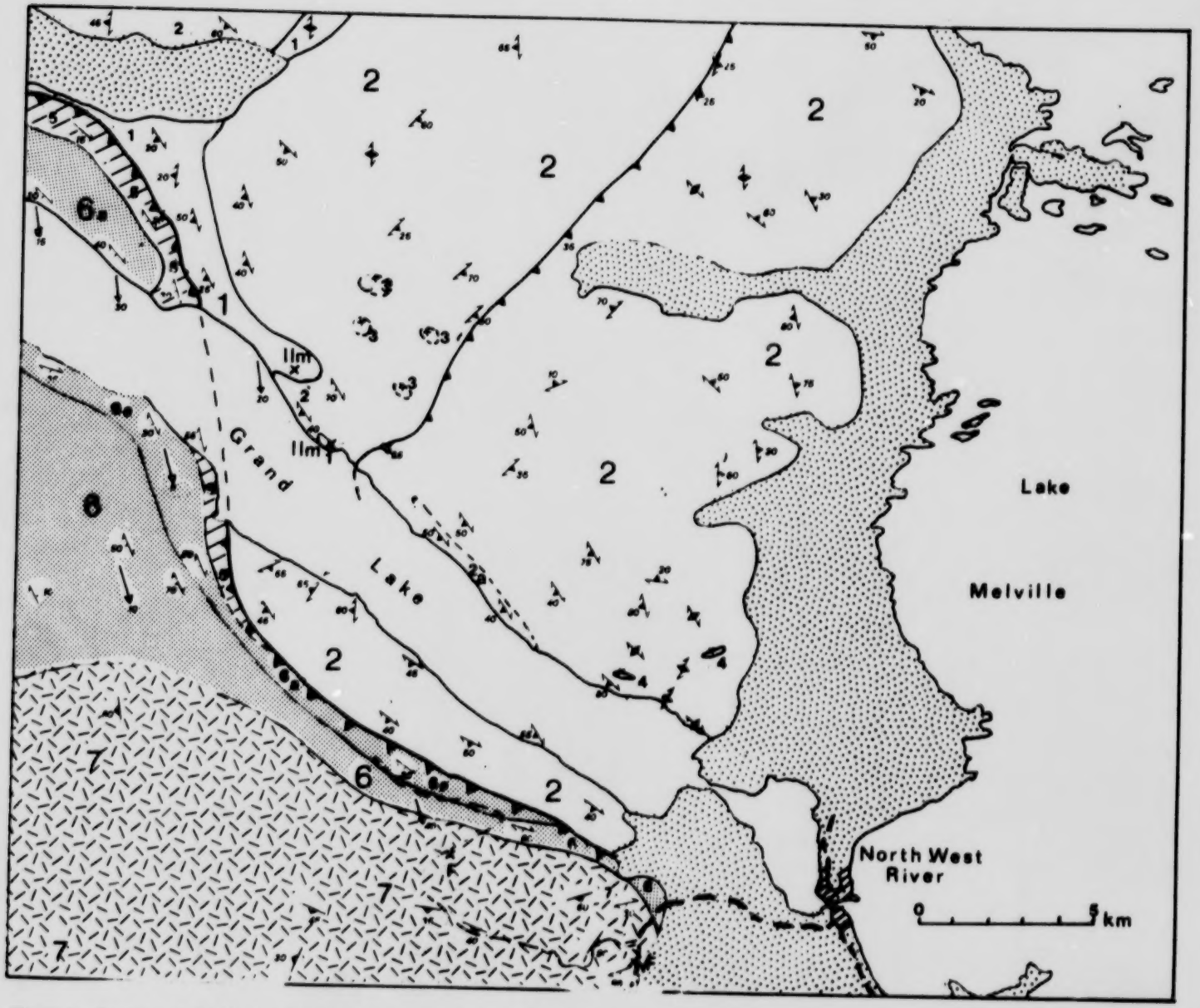

Figure 1: *Geology of the North West River area (13F/9), Labrador.*

LEGEND

Pleistocene clay, sand and till.

Cape Caribou River Nappe (Units 5-7)

HELIKIAN

7 Massive, coarse grained anorthosite.

6 Interlayered gabbro, leucogabbro and minor anorthosite passing downward into metamorphosed equivalents. **6a**, amphibolite and leuco-amphibolite.

5 Interlayered, mylonitized amphibolite, leuco-amphibolite and white granite.

THRUST CONTACT

Granitoids (Units 3 and 4)

4 Coarse grained, megacrystic biotite granite.

3 Fine grained tonalite and microgranite.

1650 Ma Pre-Grenville Gneisses (Units 1 and 2)

2 Granitoid gneiss complex composed largely of gray granodiorite gneiss with lesser amounts of pink granitic gneiss. **2a**, gray quartz diorite gneiss. All varieties contain abundant amphibolite layers.

APHEBIAN

1 Kyanite-bearing metasedimentary gneisses.

GEOLOGY OF THE DOUBLE MER WHITE HILLS AND SURROUNDING REGION, GRENVILLE PROVINCE, EASTERN LABRADOR

by

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Labrador Mapping Section

The region mapped in 1983 is a rectangular area of about 5500 km^2 situated near the northern margin of the Grenville Province in eastern Labrador. The southwest corner of the area is about 75 km north of Goose Bay.

Apart from the Double Mer Formation, all rocks were involved in the Grenvillian Orogeny. Those in the northwest experienced only fringe effects, whereas those in the southeast were severely modified. Except for one K-Ar (biotite) age of 1160 Ma on hornblende-bearing gneiss, no geochronological data are available for the map area, and the suggested age grouping of units in the legend is based largely on evidence from adjacent regions.

Probably among the oldest rocks are pelitic and psammitic paragneiss with minor calc-silicate rock and quartzite. The pelitic paragneiss grades from muscovite-bearing assemblages in the central and eastern areas into similar rocks with kyanite + K-feldspar instead of muscovite, and then to sillimanite + K-feldspar assemblages in the southeast part of the region. The calc-silicate rocks and quartzite are subsidiary rock types, although calc-silicate rocks are significant on the west flank of Double Mer White Hills.

The orthogneisses are generally very poorly exposed except in the district north of the Double Mer Formation. They range from relatively melanocratic hornblende diorite with some amphibolite, through various types of hornblende and biotite granodiorite/granite, to muscovite-biotite granite. The latter gneissic type occupies a distinct area in the central part of the region where it is associated with muscovite-bearing paragneiss and granite.

Relatively homogeneous, foliated to gneissic plutonic units have been separately distinguished on the map but some may be merely tectonic 'eyes' within their gneissic host. Granulite facies rocks include units that can be compositionally described as gabbro, diorite, monzonite, leucomonzonite and granite. A small area at the west end of Double Mer is tectonically separate from the rest of the region. The plutonic rocks present, namely K-feldspar megacrystic biotite granodiorite and hornblende quartz monzonite to granite, are comparable to units exposed farther east and southeast.

The pyroxene quartz syenite to granite is comparable to other distinctive plutons found in a similar geotectonic position both east and southeast of the present map area. The muscovite granite, however, appears to be unique in the eastern Grenville Province.

The Trans-Labrador Batholith within the map region can be subdivided into two main units, (i) a pink microgranite which is comparable to the Crooked River

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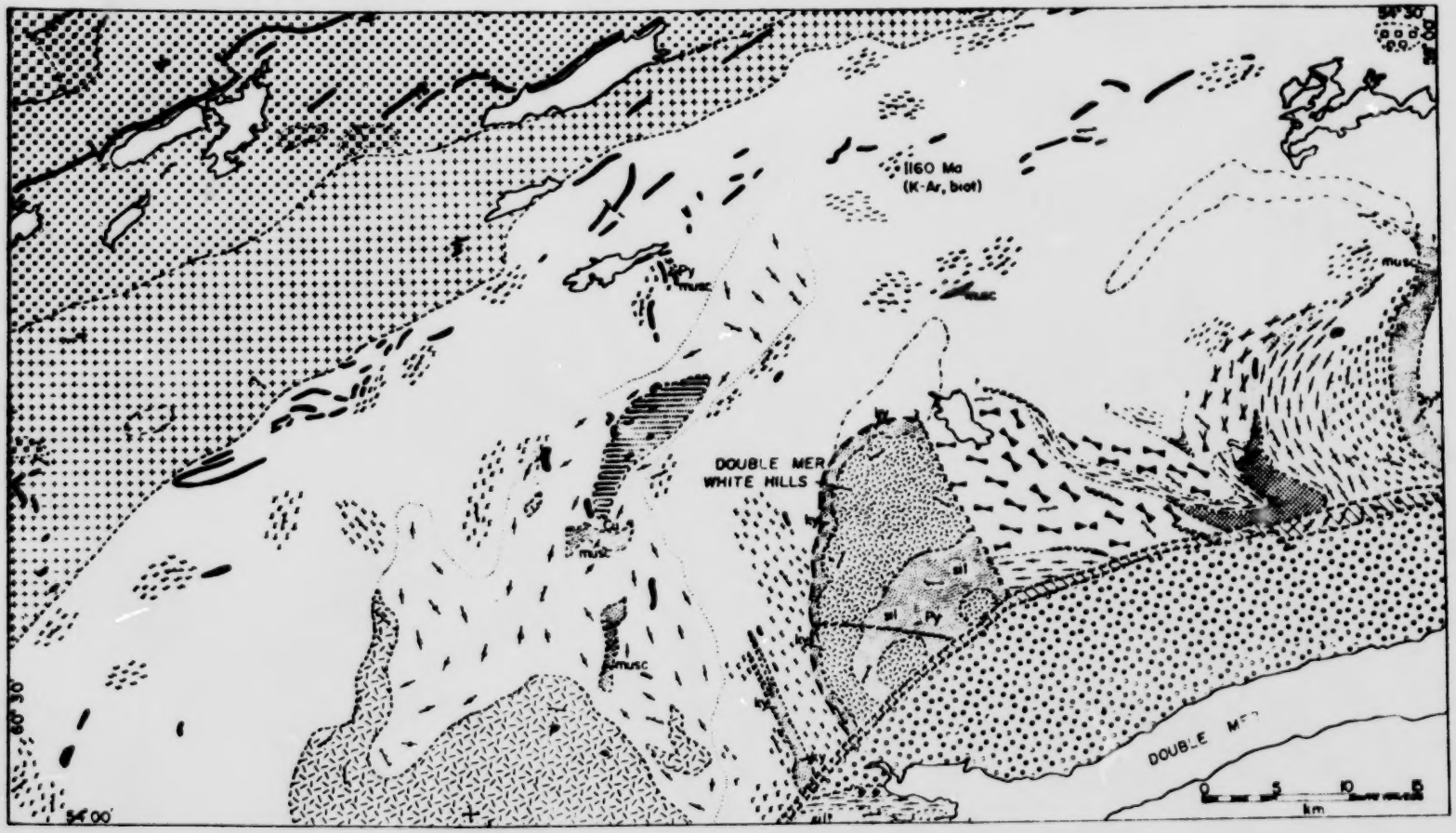

HADRYNIAN

Double Mer Formation: red arkose and minor conglomerate

HELIKIAN

Gabbro, leucogabbro, amphibolite: includes Michael Gabbro

TRANS-LABRADOR BATHOLITH

Otter Lake–Walker Lake Granite:
- Biot granite
- Biot hbl qtz monzonite
- Hbl monzonite

Crooked River Granite: pink, musc and biot microgranite

K-fs megacrystic biot granite

HELIKIAN (continued)

FOLIATED TO GNEISSIC PLUTONS

GROSWATER BAY TERRANE

Musc-rich granite

Pyx qtz syenite to granite

LAKE MELVILLE TERRANE

Hbl qtz monzonite to granite

K-fs megacrystic biot granodiorite

Leucomonzonite opx cpx granulite

LAKE MELVILLE OR TRANSITIONAL TERRANE

Opx-cpx monzonite granite granulite

Pyx-bearing diorite to gabbro

HELIKIAN AND/OR APHEBIAN?

ORTHOGNEISS GROSWATER BAY AND LAKE MELVILLE TERRANES

Musc biot granite gneiss

Biot granite gneiss

Biot granodiorite gneiss

Biot hbl granodiorite diorite gneiss

K-fs augen granodiorite gneiss

Unexposed, assumed underlain by gneiss

APHEBIAN?

Pelitic and psammitic biot gneiss, minor calc-silicate rock and quartzite

Fault breccia zone

Fault

Thrust

Geological boundary approximate, diffuse

Foliation or gneissosity

Marked aeromagnetic anomaly

Cu Py Pyrite

Ky Kyanite

sil Sillimanite

Figure 1: ***Geological map of Double Mer White Hills and surrounding region.***

Granite described farther west, and (ii) a biotite hornblende monzonite, grading locally into monzodiorite or granite which is here grouped with the Otter Lake - Walker Lake Granite. A small area of megacrystic granodiorite in the northeast corner of the area equally could be assigned to the orthogneisses.

The mafic intrusions, which include Michael Gabbro, embrace rocks of various ages. Michael Gabbro is an ophiolitic textured olivine gabbro grading southward into a garnet coronite amphibolite.

The post-Grenvillian Double Mer Formation, consisting of red and maroon arkosic sandstone with minor conglomerate, occupies a graben presently assumed to have formed during the Late Precambrian.

COASTAL LABRADOR AGGREGATE RESOURCE PROJECT

by

M.J. Ricketts
Environmental Geology Section

Introduction

1983 marked the beginning of aggregate resource inventory mapping in the coastal areas of Labrador.

The initial phase of the program included field sampling in communities from Lodge Bay to Rigolet. The project was conducted in a similar pattern to the Inventory of Aggregate Resources Program, which completed sampling within a 6 km wide corridor study area along all existing and proposed transportation routes in Newfoundland and Labrador.

Objectives

Aggregate deposits of sand, gravel, stone, etc. suitable for construction purposes are a finite nonrenewable resource. The present need in Labrador for data on these deposits is considered to be even greater than it was in Insular Newfoundland because of the lack of available information or mapped data in Labrador, and the general lack of overburden and granular materials.

By completing a mapping program of this nature, we hope to aid community development and help prepare communities for future expansion.

We plan to identify sources of sand and gravel as well as carry out field and laboratory analyses. This range of analysis is considered essential for proper resource management, i.e. to identify high grade materials that should not be used for subgrade (ballast or fill) construction and reserved for future road topping or concrete uses in local communities.

In cooperation with municipal or community councils, we plan to delineate resource sites and have them protected by zoning on the municipal plans.

The project involves locating and detailed sampling of any aggregate reserves in the proposed areas. In areas lacking quality grade aggregates, alternative sources such as silt, clay - free till and/or suitable bedrock are assessed in regards to current and future local needs. The designation of the aggregate resources as extraction areas within specific locations will ensure that aggregates can be preserved to meet the present and future demands of the domestic and commercial aggregate consumer. After the aggregate resources reserves are depleted, quarry areas are to be rehabilitated to a state suitable for other proposed uses and the area moved from the extraction designation.

Other objectives of the project are to identify surface landforms, with particular emphasis on determining areas suitable or unsuitable for a variety of purposes such as hydrogeological formations for screened or drilled wells and for various community needs (e.g. housing, recreation, roads or servicing, etc.). Geotechnical properties of the subsoil, overburden and bedrock materials were identified to assist preengi-

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Project funded by the Newfoundland Department of Mines and Energy and the federal Department of Regional Economic Expansion (Coastal Labrador Subsidiary Agreement).

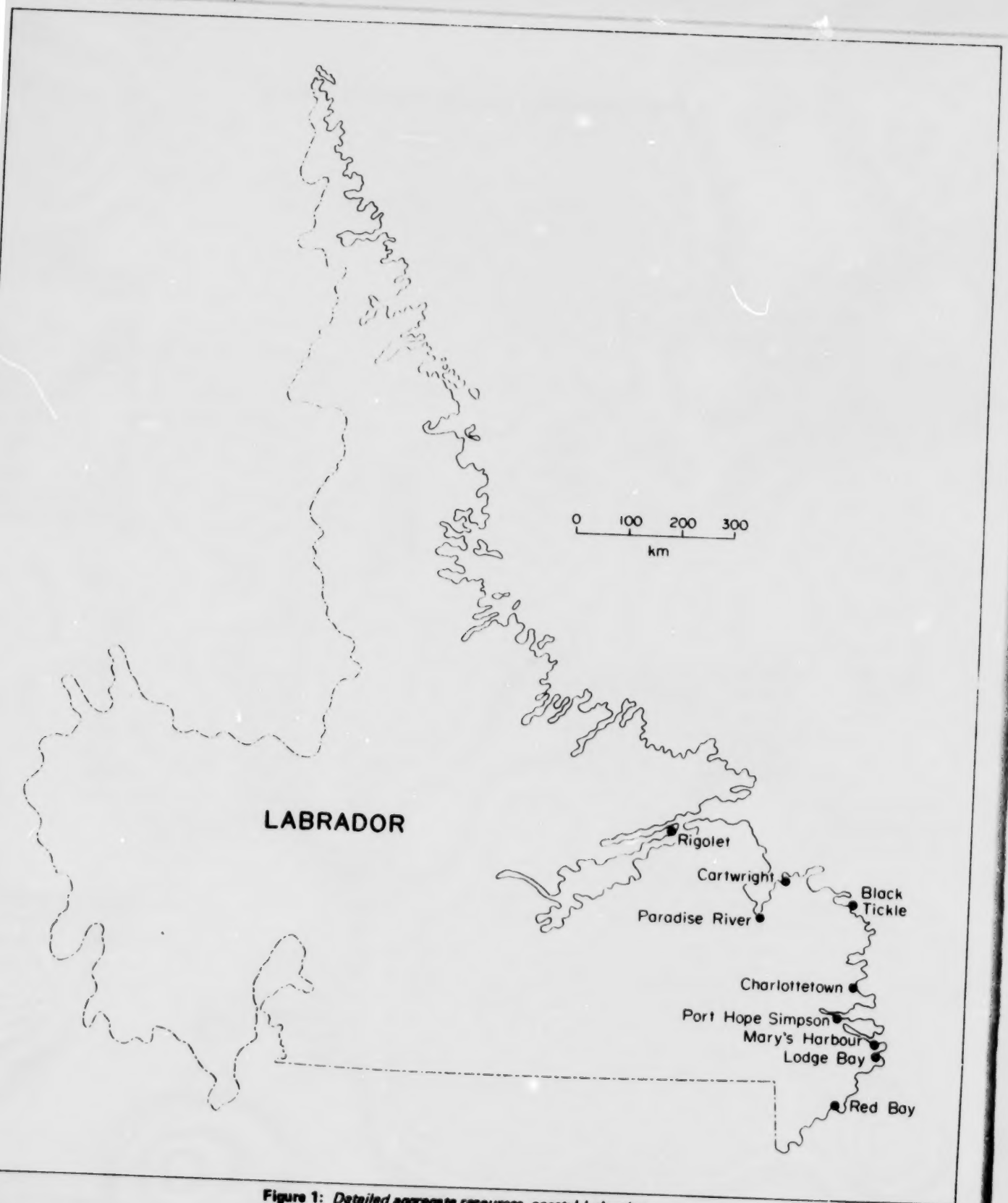

Figure 1: *Detailed aggregate resources, coastal Labrador.*

neering studies of route selection for roads or water or sewage mains.

Field Work, 1983

Field work involved sampling of overburden materials, with particular emphasis on materials suitable for construction purposes; particular attention was given to problem or hazardous areas. In addition, terrain analysis identified areas most suited for municipal services and residential development.

Field work was concentrated around the coastal communities of Mary's Harbour, Fox Harbour, Lodge Bay, Black Tickle. Charlottetown, Williams Harbour, Paradise River, Port Hope Simpson, Rigolet and Cartwright. Some reconnaissance work was also conducted at Battle Harbour, Batteau, Domino, Pinsent Arm and Spotted Island.

Field work involved extensive foot traverses to sample and accurately delineate zones of aggregate potential previously identified by aerial photographic interpretation. Helicopter and boat traverses were done in areas inaccessible by foot traversing. Approximately 200 samples were collected for particle size analysis and lithological investigation.

Mapping was normally conducted at a scale of 1:50,000, although 1:25,000 maps were used in some areas.

Office Program

During the winter of 1983-84, sample analyses will be done and maps compiled. This will include the production of two sets of 1:50,000 scale maps, consisting of approximately 15 maps each. One series of maps will include sample localities and zones of aggregate potential; the other series will show landform classification.

Work will also be started on two sets of 1:250,000 scale maps consisting of 3 maps each. One set will give a summary of aggregate zones as depicted on the 1:50,000 maps; the other 1:250,000 scale map set will give a summary of the bedrock geology with emphasis on the geotechnical aspects of bedrock, including marginal notes on each map with a unified legend.

Future Plans

Future work (subject to Management Committee approval) will include field sampling in the communities of Postville, Davis Inlet, Nain and the proposed relocation sites for Hopedale. A reconnaissance trip to these communities at the end of the 1983 field season has shown areas of aggregate potential as well as problems in some areas with regards to aggregate extraction. Davis Inlet, for example, has a sandy terrace within the community. Housing development has begun to occur at the top of this deposit. With proper mapping and sampling, this area should be designated as an area of aggregate extraction for community and local needs, to be followed later by housing development.

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DRIFT PROSPECTING STUDIES IN LABRADOR

by

R.A. Klassen*

As part of the Canada-Newfoundland co-operative minerals program, the Geological Survey of Canada began a study of the glacial history and Quaternary geology of eastern central Labrador during 1982. The principal purpose of the work is to develop techniques of drift prospecting in the region, and initial fieldwork was designed to establish the directions of ice flow and controls on the composition and geochemical properties of till.

Because the project was initially suggested and partly funded by Brinco Mining Ltd., work was begun in 1982 in the area of the Michelin uranium deposit, in the eastern part of the Central Mineral Belt (Melody Lake area; map areas 13J(W), and 13K(E)). During 1983, sampling continued in the same study area, and a similar project was initiated in the area of Churchill Falls (map areas 13E(W) and 23H(E)), making use of existing road systems to facilitate sampling.

During reconnaissance traverses made by helicopter and by four-wheel-drive vehicle, ice flow directions within the two areas were determined by measuring the orientations of striae, and surficial deposits were sampled routinely for later lithologic and geochemical analyses. Near sites of known mineralization, samples were spaced more closely to estimate the shape and geochemical character of glacial dispersal trains. Samples were collected from the least oxidized sediment encountered near the base of pits. To investigate the effect of weathering (soil development) on geochemistry, soil horizons were sampled from test pits.

The clay size (<0.002 mm) and the pebble size (2 to 4 mm) fractions of till have each been analyzed for copper, lead, zinc, cobalt, nickel, chromium, iron, manganese and uranium. To date, only samples collected during 1982 have been analyzed for trace elements.

Striae found in glacial polish on bedrock show that the last directions of regional ice flow vary within the two study areas. In the Melody Lake area, the directions of last regional ice flow were northeastward in the northern part of the area, and eastward to southeastward in the southern part. In the Churchill Falls area, the direction of last regional ice flow was generally southeastward. Earlier directions of ice flow have also been identified throughout both study areas that trend directly across the directions of last regional ice flow. The earlier directions are nearly northward in the Melody Lake area and northeastward in the Churchill Falls area. The variable nature of the glacial flow in time and space strongly indicates that the orientation of glacial dispersal trains could vary markedly in eastern Labrador, and that net glacial transport directions of mineralized

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erratics could involve at least two separate phases of ice transport.

Erratics of sedimentary rock and of iron formation derived from supracrustal sequences are widespread in both study areas and indicate that till has a far-travelled (>50 km) component that can constitute a significant fraction of pebble size and finer fractions.

Geochemistry of till was found to be strongly influenced by weathering in both the clay size and pebble size fractions. The contents of copper, lead, zinc, nickel and uranium in till are greatest within the 'C' horizon of soil profiles, and decrease upward through overlying 'B' and 'A' horizons. For geochemical sampling, till within the 'C' horizon has the highest trace metal content and provides a good basis for comparison of metal levels among samples.

Patterns of regional variation in the trace metal content of till generally follow the trends of major bedrock units in the Melody Lake area and display a prominent northeast-southwest trend. Contents of the base metals are generally higher in till in the northwestern part of the area, and contents of uranium are generally higher along the Central Mineral Belt in the central part of the area, and decrease to the northwest and southeast. Similar geochemical trends are evident by comparison of trace metals in the clay and the pebble fractions of till, although metal contents are greater and have a wider range in the clay fraction. The definition of 'anomalous' metal levels would vary within the study area, depending on local 'background' metal contents of till.

Strange Lake Deposit

GEOCHEMICAL ORIENTATION STUDIES AND QUATERNARY MAPPING AROUND THE STRANGE LAKE DEPOSIT, NORTHERN LABRADOR

by

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An intensive ten-day field study was undertaken over and around the Strange Lake Zr-Nb-Ta-Y-Be-rare earths deposit in Northern Labrador about 130 km west of Nain near the Labrador-Quebec border (Figure 1). The deposit was discovered by the Iron Ore Company of Canada as a result of following up a geochemical anomaly in the regional lake sediment and water survey carried out under the Canada-Newfoundland Uranium Reconnaissance Program.

In the regional geochemical data, the deposit is reflected by a pronounced F anomaly with associated U in lake water and Pb in the lake sediments. The deposit itself lies to the west of the regional survey, so the lake sediment and water anomalies are due to a combination of glacial and hydromorphic dispersion.

The objectives of this preliminary study are to characterize the geochemical signature of this type of deposit, and to begin the development of effective follow-up strategies for evaluating other similar regional geochemical anomalies in the province. To this end, the following sampling was carried out in NTS sheets 24A/8 and 14D/5 over the deposit and up to 20 km to the east (Figure 1):

1) High density lake sediment and water sampling from 107 sites;
2) Stream sediment and water sampling from 140 sites;
3) Till and frost boil sampling from about 200 sites, with the sample density decreasing away from the deposit.

The lake waters are being analyzed for F, U and pH. The lake sediments are being analyzed for U, Cu, Pb, Zn, Co, Ni, Cd, Ag, Mo, F, Mn, Fe and LOI (the suite determined on the regional sample set). In addition, they will be analyzed for W, Be, Th, Y, Li and rare earth elements. In a recent survey by the Quebec Department of Energy and Resources in the adjacent area of Quebec, it appears that Be, Ce, Th, Y, Eu, La, and Sm in lake sediment may be useful guides in locating this type of deposit (Beaumier, 1982). From the samples collected this summer, it should be possible to characterize fully the geochemical signature of the deposit in lake sediments. A similar range of elements will be determined on the stream sediments and waters; in addition, Sn will be included for the stream sediments.

For the till and frost boil samples, a similar wide range of elements (including Sn) will be determined to find the most useful suite of elements with which to map the glacial dispersion train from the deposit. In addition, lithologic and particle size analyses of

Project funded by the Newfoundland Department of Mines and Energy

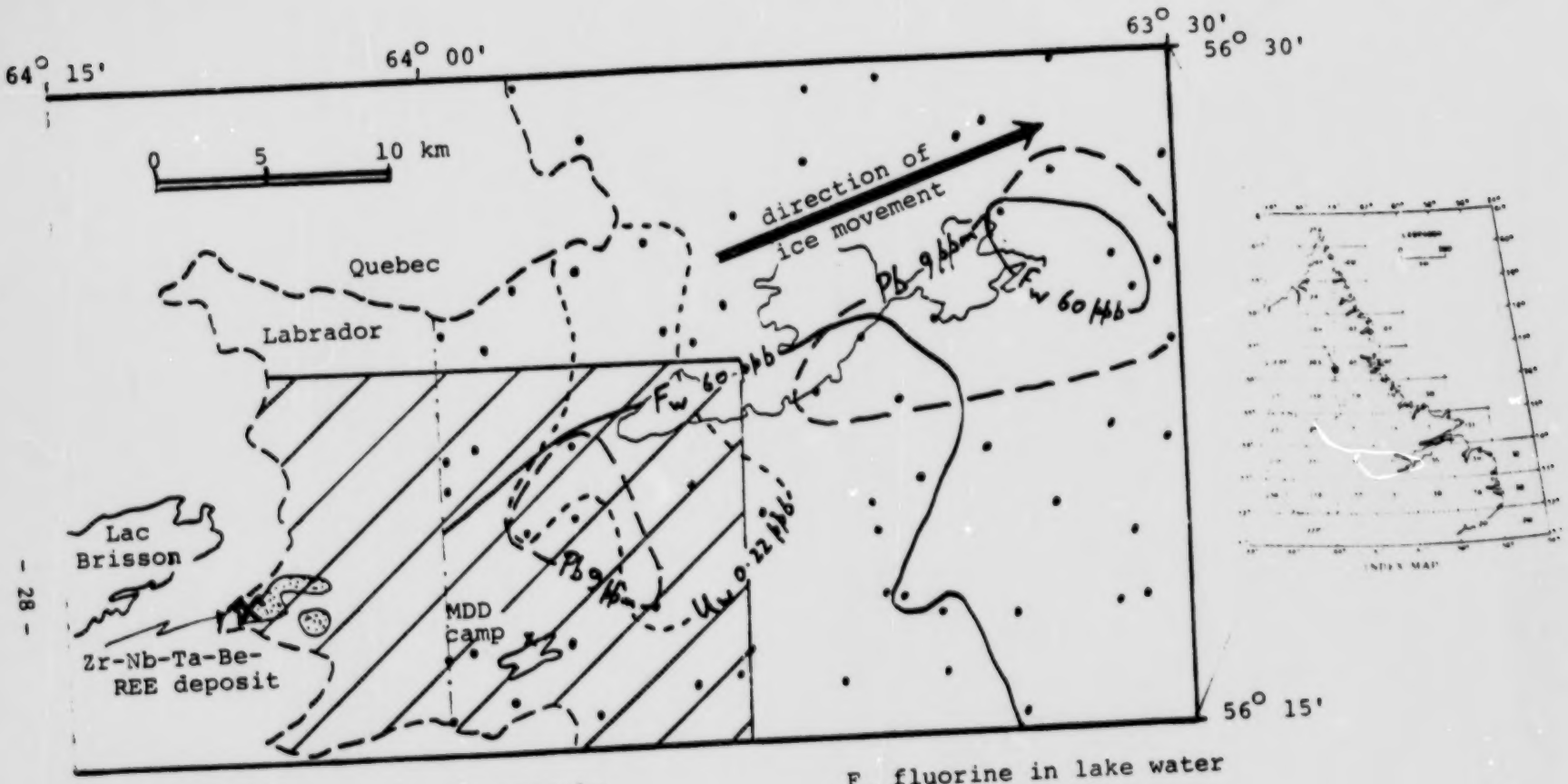

Fig. 1. Area of till, frost boil, stream sediment and water, and detailed lake sediment and water sampling (cross-hatched) in the "Strange Lake" area, Labrador. Also shown are the regional geochemical survey sample sites and anomalies in F, Pb and U related to the deposit, and the airborne gamma-ray anomaly in eTh (Geological Survey of Canada 1983).

tills will be conducted. In conjunction with more detailed till sampling being carried out by R.N.W. DiLabio of the Geological Survey of Canada, we should be able to provide a well documented example of the application of till and frost boil sampling at both semi-regional and detailed scales in exploration for this type of deposit.

As a background to our lake, stream and till sampling, a 1:50,000 scale Quaternary geology map was prepared from aerial photographs and verified in the field at selected locations. This will provide a framework for the interpretation of the geochemical data, and also for the results of the airborne gamma-ray survey of NTS sheets 24A/1 and 24A/8 released in September, 1983, by the Geological Survey of Canada (1983).

After all the data are compiled, a comprehensive case history for effective exploration for this type of deposit from regional geochemical data will be constructed.

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Western Newfoundland

HIGHLIGHTS OF FIELD WORK IN THE PRECAMBRIAN TERRANE OF THE NORTHERN LONG RANGE MOUNTAINS, WESTERN NEWFOUNDLAND

by

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Setting

The Precambrian terrane of the northern Long Range Mountains is a high grade granite gneiss complex giving regional K-Ar ages in the order of 950 Ma, and generally assumed to be an inlier of the Grenville Province in the miogeoclinal belt of the Appalachian Orogen. It occupies approximately 8500 km^2 of the Great Northern Peninsula of Newfoundland (Figure 1). Of this area, only about 2000 km^2 have been mapped systematically, at 1:125,000 scale (Bostock, 1983); little is known about the remaining portion, which extends over parts of fourteen 1:50,000 scale NTS map areas.

In preparation for mapping at 1:100,000 scale of the remaining area, which is to be initiated as a joint federal-provincial project, a reconnaissance was carried out in the summer of 1983. The main objectives were to map two strips of the terrane, one along the northeast trending coastal section and the other across the southern portion of the region. A secondary objective was the examination of the area to be flooded in 1984 by the Cat Arm Hydro Development, and of the bedrock exposed during the construction of dams and tunnels.

Summary of Results

Mapping along the east coast reveals that most of the area is underlain by a migmatitic quartzofeldspathic gneiss complex which includes a variety of granitic and amphibolitic units, as well as layers of quartzite, chlorite and biotite schist, and other minor rock types of inferred metasedimentary protolith. Where the metasedimentary rocks are extensive, they are differentiated as a separate unit on Figure 1. Several bodies of coarse grained, megacrystic granitic rocks crosscut the gneiss complex. Numerous mafic dikes of the Late Hadrynian Long Range swarm intrude all the above units.

In the southern transect, a similar quartzofeldspathic gneiss complex appears to be the oldest unit of the area. A large domal or steeply plunging antiformal structure within the gneiss complex has a core of granulite facies gneiss characterized by the presence of hypersthene and waxy green feldspars. The gneiss complex includes strips of marble and calc-silicate rocks near the margin of a large gabbro-anorthosite complex exposed in the southeast, which appears to have intruded the gneissic rocks. A body of coarse grained granite exposed in the southwest, which has gradational contacts with the adjacent gneiss, may be part of the megacrystic suite exposed on the coast.

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Contribution to the Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Geological Survey of Canada.

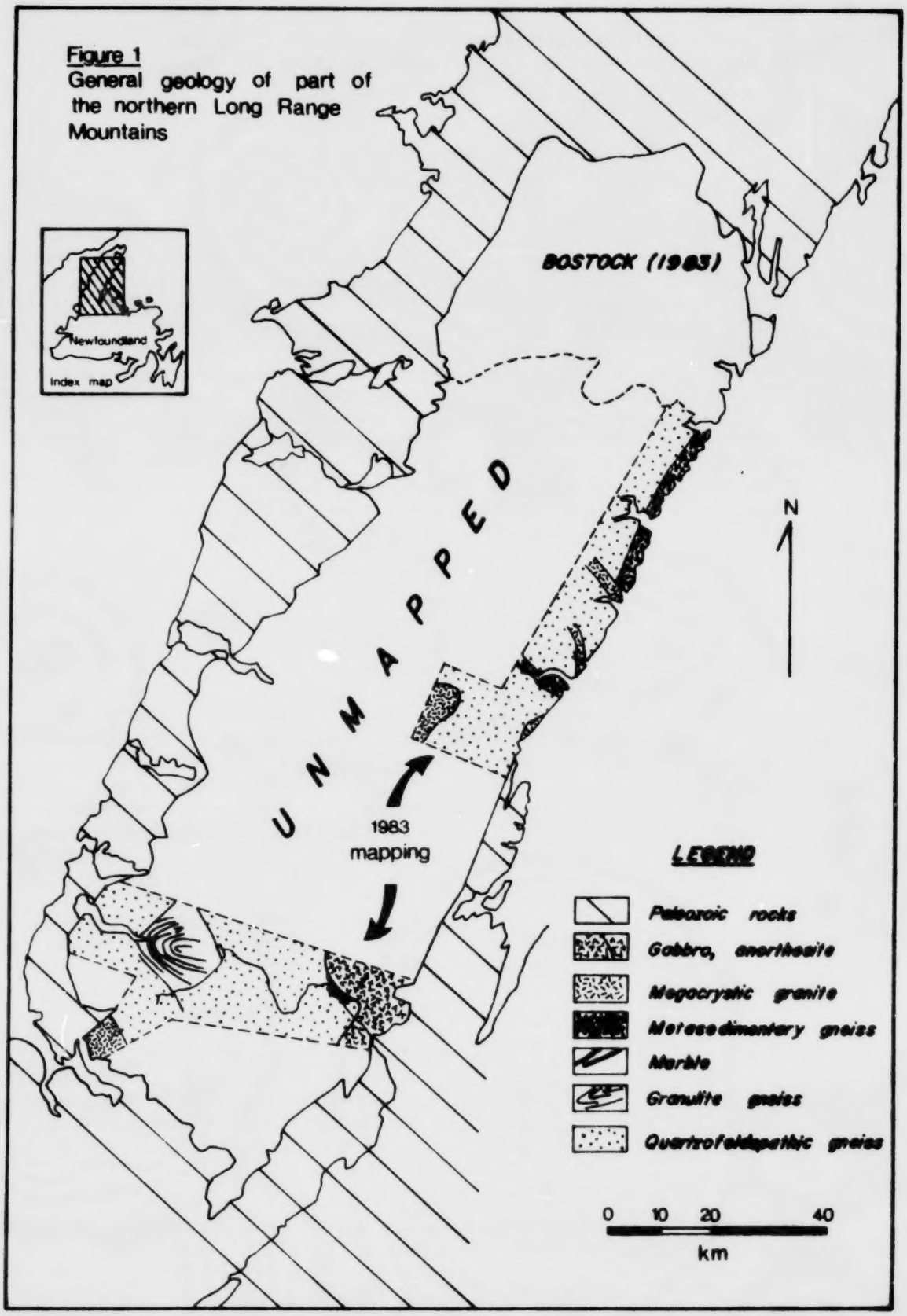
Figure 1
General geology of part of the northern Long Range Mountains
Newfoundland
Index map
BOSTOCK (1983)
UNMAPPED
1983 mapping
N
LEGEND
Paleozoic rocks
Gabbro, anorthosite
Megacrystic granite
Metasedimentary gneiss
Marble
Granulite gneiss
Quartzofeldspathic gneiss
0 10 20 40
km

GEOLOGY OF THE PORT SAUNDERS (121/11) AND THE ST. JOHN ISLAND (121/14) AND PARTS OF THE TORRENT RIVER (121/10) AND BELLBURNS (121/6) MAP AREAS, NORTHWESTERN NEWFOUNDLAND - PRELIMINARY STATEMENT

by

Ian Knight

Introduction

Geological mapping of Cambro-Ordovician platformal strata was completed in the Port Saunders, St. John Island and Torrent River map areas. Mapping has begun on the northern half of the Bellburns map sheet.

The autochthonous Lower Paleozoic strata unconformably overlie Precambrian granite and gneissic basement along the western margin of the Torrent River map sheet. Basal Lower Cambrian sandstones rest upon an irregular ancient land surface. Some topographic highs of this surface are associated with basement lineaments that are also truncated by the unconformity. Other lineaments appear to have been reactivated by later earth movements. These cut across the unconformity and affect the overlying sedimentary rocks.

Stratigraphy

Four groups that comprise the platform sequence throughout western Newfoundland are present in the map area. They are, in ascending order: the Lower Cambrian Labrador Group, the Middle to Upper Cambrian Port au Port Group, the Lower Ordovician St. George Group and the Middle Ordovician Table Head Group.

Labrador Group

The Labrador Group (approximately 400 m thick) consists of the Bradore, Forteau and Hawke Bay Formations which are dominantly siliciclastic with minor carbonate rocks. Red, crossbedded and poorly sorted, granulose and pebbly arkosic sandstone is the dominant facies of the Bradore Formation in the west of the area (St. John Island map sheet), although some gray sandstones and *Scolithus* - bearing, well sorted sandstones also occur. However, 15 to 20 km to the east on the Torrent River map sheet the coarse red beds are restricted to the basal few metres of the formation. Here they are subordinate to an overlying sequence (of unknown thickness) of gray to pink, glauconitic, very fine sandstone and siltstone and lesser amounts of gray shale and *Scolithus* - bearing, well sorted quartz arenite with some intercalations of red arkose. The sandstones were deposited in environments ranging from braided streams to nearshore and shoreline settings. The overlying Forteau Formation is not well exposed in the area as a whole. It is composed of a lower, in the main, interbedded gray shale and extensively bioturbated sandstone seqeunce deposited on a mixed mud and sand shelf, and an overlying higher energy shelf sequence of grainy carbonates. The latter include

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Contribution to Canada-Newfoundland co-operative mineral program 1982-84. Project financed by the Newfoundland Department of Mines and Energy.

black, fossiliferous, oolitic and oncolitic limestones, gray oncolitic limestones, gray fossiliferous lime grainstone, crossbedded sandy limestone and minor bioturbated sandstone and shale. Archaeocyathid reefs occur in this upper sequence and have been found at a new location near Hawkes Bay. The conformably overlying Hawke Bay Formation is dominated by well sorted, flinty, white quartz arenite deposited in a shoreline to shallow shelf environment. Interbedded at intervals within the white quartz arenite are sequences of red, gray and green sandstone and shale that are phosphatic and glauconitic, and display abundant evidence of deposition in intertidal sand and mud flats.

Port au Port Group

The Port au Port Group (>400 m) rests conformably upon the Hawke Bay Formation and comprises two units, the March Point and Petit Jardin Formations, both composed mostly of recessively weathering dolostone. The March Point formation consists of approximately 65 m of rusty weathering, dark gray, thinly bedded, vuggy, argillaceous dolostone with a thin shale and sandstone sequence at the base. The bedded dolostone is bioturbated, and contains some intraformational breccia and a restricted inarticulate brachiopod fauna that suggests it was deposited in shoreline and shallow shelf environments. The overlying Petit Jardin Formation contains yellow to buff weathering, pale gray dolostone, minor limestone and red, green and gray shales. The formation contains stromatolitic boundstone and abundant sedimentary structures and sequences that attest to deposition in peritidal, shoreline settings.

St. George Group

Sitting conformably above the Cambrian rocks are limestone, dolostone and diagenetic dolomite of the St. George Group. The basal Watts Bight Formation is approximately 100 m thick, generally well exposed, and typified by dark gray to black, bituminous, cherty, diagenetic dolomite. It exhibits thick boundstone mound beds and complexes associated with thick beds of burrow-mottled, thinly stratified, (now dolomitized) carbonate muds typical of subtidal shelf deposition.

The overlying Boat Harbour Formation generally weathers recessively and is not well exposed, except along shoreline sections. It consists of some 150 m of cyclically intercalated subtidal limestone, stromatolitic and thrombolitic lime boundstone and intertidal and supratidal flat limestone and dolostone that were deposited in a fluctuating carbonate strandline environment. A disconformity is believed to interrupt the sequence close to the top of the unit. Diagenetic dolomite has replaced the limestone extensively in the lower 50 m of the formation. Bedded breccias also occur in the same interval; it is presently unclear if they are of sedimentary collapse or of tectonic origin.

Well bedded, fossilifeorus, bioturbated, gray limestone which displays extensive dolomite burrow-mottling. forms the Catoche Formation. This distinctive and well exposed unit, 160 m thick, conformably rests upon the Boat Harbour Formation and commonly forms ridges in the area. Several beds of thrombolitic boundstone mounds also occur in the formation which was deposited in an open, subtidal shelf environment. Bituminous, vuggy, light to dark gray diagenetic dolomites extensively replace limestone (though still preserve depositional fabrics) of the upper 34 to 50 m of the Catoche Formation. They locally possess high porosity and are rich in sparry dolomite vug-fill (pseudobreccia). Mapping suggests that such diagnetic dolomites locally pass laterally into insignificantly altered dolomitic limestone.

Overlying the Catoche Formation in the area mapped is the poorly exposed and recessively weathering Aguathuna

Formation. This unit is composed of yellow weathering siliceous dolostone and argillaceous dolostone which were deposited in restricted intertidal and supratidal flat - settings. Collapse breccias were noted locally in the map area. At Port au Choix where the dolostone appears to overlie the diagenetic dolomite conformably, the formation is only 4 m thick, in marked contrast to the approximately 57 m that occurs in the formation at Table Point (Bellburns map sheet), 40 km to the south. Preliminary studies suggest that only the topmost beds in the Table Point section occur at Port au Choix. These facts combine to suggest strongly that either there is a major facies change from northwest to southeast involving subtidal limestones of the Catoche Formation passing south into intertidal dolostone of the Aguathuna Formation or that a disconformity separates the Catoche and Aguathuna Formations at Port au Choix and that the disconformity may occur somewhere within the Aguathuna Formation in the Table Point section. If a disconformity is indeed present then this implies that the Lower Paleozoic platform in western Newfoundland was topographically uneven during the time interval when the Aguathuna Formation was deposited. Although no evidence of erosion is present in the map area there is evidence that suggests the platform at this time was being dissected at least by high angle northeast trending faults. In the Port Saunders map area, near Hawkes Harbour, minor northeast trending faults and fractures cut the Catoche Formation. Crossbedded and meniscus-bedded, buff weathering, dolomite-cemented, chert- and vug-quartz sandstones fill open spaces along the faults, and the fills themselves are cut by shears indicating later fault movements. In the same area, eastward dipping fractures were dilated by stresses or solution and are now filled by buff weathering, silty dolomite mudstone. Although there is no conclusive evidence that the fracture-fills are of Early Ordovician age, they nontheless appear to be lithologically very similar to sandy dolarenite that contains vug- and chert-quartz sand grains and dolargillite in the Table Point section of the Aguathuna Formation. This interpretation of the fracture-fills as late Early Ordovician in origin supports the deformation of the platform by a phase of block-faulting during the depositional time interval of the Aguathuna Formation.

Table Head Group

Shoreline to subtidal shelf limestones of the Table Point Formation rest conformably upon the dolostone of the Aguathuna Formation in the map area. The former formation contains three units which presently appear to be arranged in ascending order. Cyclically developed, burrow-mottled, fossiliferous lime mudstone and laminated, in places mud-cracked, fenestral dolostone or dolomitic lime mudstone form a basal unit 12 m thick. These beds of peritidal origin are overlain by a unit of unknown thickness of thickly bedded, white to light gray weathering, gray, fenestral limestone with dolomite- and calcite-filled fenestra. This in turn is overlain by well bedded. blue-gray, fossiliferous, rubbly weathering limestone which characterizes much of the Table Point type section. Slump breccias are common in the upper unit near Port au Choix. Surprisingly, diagenetic dolomite widely replaces limestones of the lower and middle and locally upper members of the formation. Some of the dolomite is sparry dolomite-rich pseudobreccia generally claimed to be restricted to the St. George Group.

Structure

Long, curvilinear, braided and anastomosing, northeast to north trending faults transect the map area. The faults offset the stratigraphic boundaries many kilometres in both directions. Vertical throws of hundreds of metres occur across several of the faults. Fault breccias are locally developed and carbonate rocks

extensively dolomitized close to faults. Strata between faults are either gently inclined and consistent in strike or gently warped about southwest plunging fold axes. However, close to faults, beds may locally dip steeply and be overturned; tight, locally recumbent folds also occur. Evidence that strike-slip movements were important on these faults is provided by the folds. In many instances the fold axes strike obliquely at an angle of 25° into the faults, and at several localities drag folds suggest a sense of movement upon the fault opposite to that which would be expected if simple vertical displacements had juxtaposed the rock units now facing each other across the faults. A north trending cleavage locally developed in limestones of the Table Point and Catoche Formations is probably also the product of compressive stresses developed locally within the braided fault system as strike-slip movements occurred along the faults.

The oblique trend of the folds associated with two of the major faults, the Port Saunders and Torrent River faults, suggests that right-lateral movements occurred. However, left-handed offset of stratigraphic markers across at least one of these faults and a number of its splays suggests however that a phase of sinistral strike-slip movements may also have affected the platformal strata. Vertical movements have also occurred on the faults.

Mineralization

Minor sphalerite, galena, chalcopyrite, barite, fluorite and cerussite showings have been found in the map area. Sphalerite, galena and cerussite ($PbCO_3$) are found disseminated or filling vugs in dolostones of the March Point and Petit Jardin Formations. The best known showing of sphalerite and galena with associated chalcopyrite is that near Pikes Feeder Pond on the Torrent River sheet (Beckett, 1966). Cerussite was discovered in dolostone of the Petit Jardin Formation in the same area.

Fluorite as disseminated crystals or vug-filling occurs in dolostone and limestone of the Boat Harbour Formation near Eddies Cove west. Sphalerite has also been reported from the basal 50 m of the formation in the same area (Shearer, 1964; Beckett, 1966). Pyrite showings were found in the base of the formation on Round Head Island.

Galena and sphalerite were recovered from calcite-dolomite veins cutting dolomitized Catoche Formation on the northwest shore of River of Ponds Lake. The veins appear to be related to a minor fault that occurs in nearby outcrops and which is probably related to the Torrent River fault that trends through the lake less than 300 m offshore.

Sphalerite, galena, pyrite and minor barite have been recovered at three locations on St. John Island. The minerals occur in diagenetic dolomite and pseudobreccia replacing limestone of the Table Point Formation.

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DOLOMITE AND DOLOMITIZATION OF THE ST. GEORGE GROUP (LOWER ORDOVICIAN) OF WESTERN NEWFOUNDLAND

by

Douglas W. Haywick* and Noel P. James*

Dolomite makes up approximately one-third of the carbonates in the St. George Group of western Newfoundland. Six varieties are now recognized.

Dololaminites are ubiquitous, composed of very fine crystals, characteristically laminated and thought to have been formed in shallow marine to supratidal environments. Intramurous dolomite preferentially replaces trace fossil walls as well as certain fossilized shells, is concentrated along stylolites, and is responsible for the dolomitic mottling so prevalent within the St. George Group. Pervasive dolostone is also mottled, but is the result of two different types of dolomite, one with finer crystallinity than the other. Matrix dolomite replaces carbonate mud between allochems and burrows and, when extensive, expands to replace the whole rock. Cavity-filling dolostone is finely crystalline and fills dissolution cavities or voids within pre-existing dolostone; it may be related to unconformities. Saddle dolomite fills late-stage fractures and voids, and in combination with pervasive dolostone is responsible for "pseudo breccia" beds associated with economic deposits of sphalerite.

Dololaminites are the earliest, probably synsedimentary, dolostones while saddle dolomite, because it crosscuts most other varieties, is clearly the latest. The fact that saddle dolomite is restricted to areas in the northern portion of the Northern Peninsula implies that this area was affected by a later dolomitization event which did not occur in more southern regions.

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Central Newfoundland

GEOLOGY AND MINERAL DEPOSITS OF THE LUSHS BIGHT GROUP, NOTRE DAME BAY, NEWFOUNDLAND

by

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Geological and mineral deposit studies in the Lushs Bight Group continued during the 1983 field season. This is the final year of a two-year program initiated in 1982.

Approximately two-thirds of the field season was spent mapping the Lushs Bight Group at 1:50,000 scale in order to delineate its stratigraphy and structure. The remainder of the field season was spent studying the mineral showings, occurrences and prospects in the group.

The main results of the 1983 field season are:

(1) A distinctive unit of chocolate-brown argillite and common jasper marks the top of the Lushs Bight Group.

(2) Banded pyrite, pyrrhotite and magnetite are commonly interbedded with these sediments.

(3) Rocks assigned to the Lushs Bight Group on Pilley's and Triton Islands are lithologically different from the Lushs Bight Group and should be removed from that group.

(4) The volcanic rocks of the Lushs Bight Group are locally subdivisible into different lithological units.

(5) Highly variolitic and quartz amygdaloidal pillow lavas are generally associated with mineralization.

(6) The sequences on Pilley's and Triton Islands display monoclinal folding.

(7) Mineralization occurs in chlorite schist derived from pillow lava and/or intercalated tuff.

(8) Most mineralization occurs as disseminations and stringers; banded or bedded sulfides occur in a few showings.

Regional Geology

The regional geology of the Springdale Peninsula has been described previously by a number of workers including MacLean (1947), Williams (1962) and Peters (1967). Dean (1978) summarized the regional geology of Notre Dame Bay, and the map area is included in a 1:250,000 scale geological compilation of the Newfoundland Central Volcanic Belt (Kean, 1977). The following regional discussion is adapted from Kean (1983).

The Lushs Bight Group occurs in western Notre Dame Bay, north of the Lobster Cove Fault. It outcrops between Southwest Arm in the west and Badger Bay

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Contribution to Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Newfoundland Department of Mines and Energy.

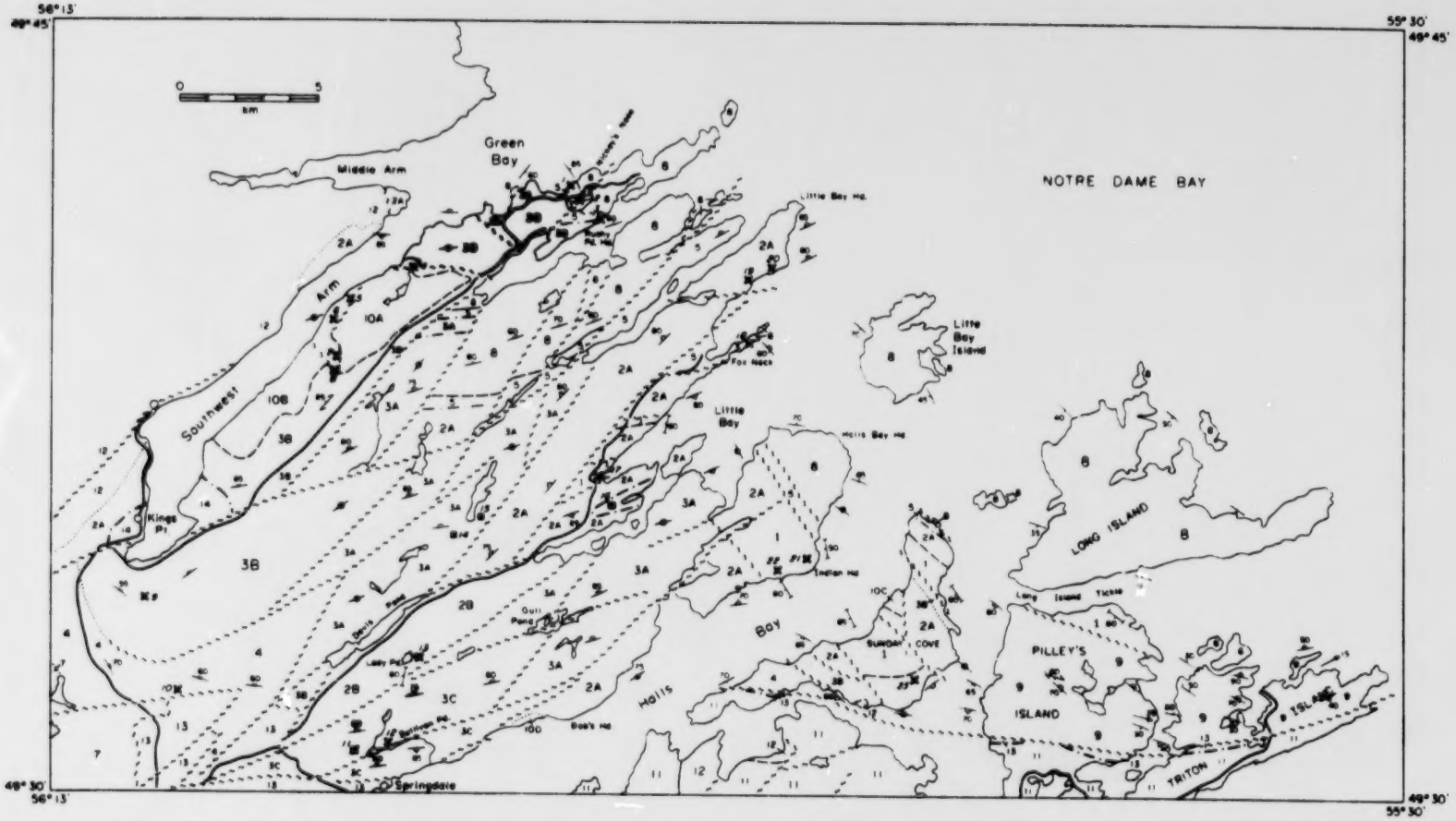

Figure 1: *Simplified geology of the Lushs Bight Group, Notre Dame Bay, Newfoundland.*

LEGEND

Carboniferous

14 Reddish brown to greyish red conglomerate and sandstone; grey shale and siltstone and minor limestone.

Silurian to Devonian

SPRINGDALE GROUP (Unit 13)

13 Red and brown conglomerate, sandstone and siltstone; minor volcanic rocks.

12 Pink to red granite, granodiorite and quartz-feldspar porphyry.

Ordovician or Silurian

ROBERTS ARM GROUP (Unit 11)

11 Undivided mafic and felsic volcanic rocks.

Lower to Middle Ordovician

10 10A, Colchester Pluton: medium grained diorite, quartz diorite and minor granodiorite. 10B, Coopers Cove Pluton: fine to coarse grained diorite, granodiorite and granite, common diabase. 10C, Wellmans Cove Pluton: medium grained diorite and quartz diorite with mafic and ultramafic inclusions. 10D, Bob Head Pluton: medium to coarse grained diorite, gabbro and quartz monzonite.

WESTERN ARM/CUTWELL GROUPS (Unit 8)

8 Massive and pillow basalt and andesite, locally feldsparphyritic. Lithic and pyroxene crystal-lithic tuff, lapilli tuff, breccia and agglomerate. Epiclastic and sedimentary rocks.

9 Highly vesicular pillow basalt and feldsparphyric andesite. Lithic and pyroxene crystal-lithic tuff, lapilli tuff and breccia. Interbedded red and green argillite and tuff.

CATCHERS POND GROUP (Unit 7)

7 Silicic lava, agglomerate and tuff; massive basalt, pillow lava and agglomerate; thin beds of fossiliferous limestone and limestone conglomerate.

Lower Ordovician and Earlier

LUSHS BIGHT GROUP (Units 1-6)

6 Brighton Gabbro: medium to coarse grained, hornblende clinopyroxenite, hornblendite, gabbro, diorite and quartz diorite.

5 Black, locally hematitized, pillow lava with common interpillow and lenses of jasper. Overlain by thinly bedded, chocolate-brown argillite and interbedded red chert.

4 Thinly bedded, grey green and black, mafic tuff and volcanic sediment; minor red argillite and chert. Magnetite lenses and magnetite rich tuff locally present.

3A Fine grained to aphanitic, gray to green, epidotized, pillow lava with common diabase and gabbro dikes.

3B Fine grained to aphanitic gray to green, commonly epidotized pillow lava with extensive pillow breccia and isolated pillows in places. Intercalated mafic tuff, locally extensive.

3C Fine grained to aphanitic, gray to green, commonly epidotized pillow lava and extensive chlorite schist; highly variolitic and quartz amygdaloidal in places. Mafic agglomerate, breccia and tuff; minor dacitic rocks. Extensive diabase dikes in places and locally sheeted.

2A Fine grained to aphanitic, gray-green to green, epidotized pillow lava with extensive diabase and gabbro dikes. Minor agglomerate and breccia. Chlorite schist extensive in places.

2B Undivided sheeted dikes and pillow lava with extensive dikes; locally variolitic. Minor mafic agglomerate, breccia and tuff. Minor dacitic rocks.

2 Sheeted diabase dikes; locally with gabbro and pillow lava screens.

Variolitic and quartz amygdaloidal pillow lava

in the east. The group is faulted against the Silurian-Devonian Springdale Group and the Ordovician-(?)Silurian Roberts Arm Group along the Lobster Cove Fault to the south. There are local outliers of the Springdale Group within the Lushs Bight Group north of the Lobster Cove Fault. These rocks are generally fault-bound; however, an unconformity on the Lushs Bight Group possibly exists in the Davis Pond area (McGonigal. 1970). It is conformably overlain by the Lower Ordovician Western Arm Group and presumably by the Lower Ordovician Catchers Pond Group to the north and west. The Lushs Bight Group is faulted against the Cutwell Group on the northeast coast of Sunday Cove Island. This fault is presumed to continue underwater between Long Island and Pilley's Island and to juxtapose these groups in that area.

The Lushs Bight Group is considered to be of ophiolite affinity. However, the Lushs Bight Group as defined by Espenshade (1937) and used by MacLean (1947) also included sedimentary and volcanic rocks now considered to be of island arc affinity. These rocks have since been assigned to the Western Arm Group (Marten, 1971) and the Cutwell Group (Kean, 1973, 1983). Thus, the group now includes only mafic pillow lava, breccia and agglomerate, sheeted diabase dikes, gabbro dikes and sills and small bodies of ultramafic rock of ophiolite type. These rocks are low potash tholeiites with strong chemical similarities to modern oceanic crust (Papezik and Fleming, 1967; Smitheringale, 1972; Strong, 1973).

The Lushs Bight Group is folded into major northeast trending folds with the limbs displaced or cut off by northeast trending wrench faults. Later deformation resulted in folding about a north-south axis resulting in southeast strikes.

The Lushs Bight Group is cut by various intrusives of probable Ordovician age including the Colchester pluton, the Coopers Cove pluton and many small stocks and plugs interpreted to be contemporaneous with volcanism. It is also thought to be intruded by the Brighton gabbro complex, which gives an $^{40}Ar/^{39}Ar$ radiometric age of 495±5 Ma (Stukas and Reynolds, 1974). A Late Cambrian age is thus suggested for most of the group.

MacLean (1947) reported a single Lower Ordovician brachiopod, *Discotreta* sp., from the lowermost part of the conformably overlying Western Arm Group.

The Lushs Bight Group and overlying volcanic sequences are correlative on the basis of age and stratigraphy with the Snooks Arm Group, which includes the Betts Cove ophiolite. The two groups are interpreted to lie on opposite limbs of a major syncline.

General Statement

Regional mapping conducted under this project has shown that the Lushs Bight Group is divisible into a number of fault-bounded blocks. With the fault-bounded blocks, the group can locally be subdivided into different stratigraphic units and/or different lithological units. The two main stratigraphic units are sheeted dikes (Unit 1) and mafic volcanics (Unit 2-5). The volcanic rocks locally can be subdivided into different stratigraphic and/or lithologic units. The predominant rock type is fine grained to aphanitic, graygreen and green pillow basalt. The pillow lavas are further subdivided based on the proportion of diabase dikes to pillow lava (Units 2 and 3A), by the presence of varioles and quartz amygdules, by the presence of extensive pillow breccia (Unit 3B) and/or extensive intercalated mafic tuff (Unit 3C). Unit 4 consists essentially of mafic tuff, agglomerate and volcaniclastic sediments with intercalated pillow lava.

The mafic volcanics (Unit 5) in the top of the Lushs Bight Croup are generally black in color rather than the usual green color, are often hematized

and commonly contain interpillow jasper, jasper lenses and, locally, magnetite lenses. The mafic volcanics are overlain by a distinctive unit of thinly bedded, chocolate-brown argillite and red chert. These sediments are in turn overlain by green, gray and yellowish tuff and argillite and pyroxenite crystal-lithic tuff (see also Kean, 1983).

The sequence (Unit 9) north of the Lobster Cove Fault on Pilley's and Triton Islands consists of pyroclastic rocks with intercalated vesicular pillow lava, and is lithologically different from the main portion of the Lushs Bight Group. It is proposed that this sequence be removed from the Lushs Bight Group. This sequence is lithologically and stratigraphically similar to the rocks of the Cutwell and Western Arm Groups (Unit 8).

The rocks of this area have been folded about northeast trending fold axes. These early or first phase(?) northeast trending structures have been openly folded or kinked about north trending axes resulting in southeast strikes. North facing monoclinal folding is developed in the sequences north of the Lobster Cove Fault. Major northeast trending faults cut the major fold structures.

The sulfide mineralization associated with the mafic volcanic rocks of the Lushs Bight Group occurs within the pillow lava and also within thin units of fine grained tuff in the pillow lava. The mineralization occurs at different stratigraphic levels within the pillow lava sequence. The mineralization consists of pyrite, pyrrhotite, chalcopyrite, magnetite, minor sphalerite and minor values of gold and silver. Magnetite lenses and magnetite-rich chert are locally developed. The mineralization occurs as ellipsoidal zones within chlorite schist zones that are coplanar with bedding. It occurs mainly as dissemination and veins in the chlorite schist. Massive pods occur in some of the mines and bedded sulfide occurs locally.

Banded pyrite, pyrrhotite and minor magnetite are interbedded with the chocolate-brown argillite overlying the mafic volcanics in the Nickey's Nose to Rushy Pond Head and the Fox Neck areas. In the Nickey's Nose area, the mineralization occurs over a width of 10 by 100 m. The mineralization continues along strike towards the Rushy Pond showing, a distance of approximately 0.5 km. At Rushy Pond Head, the mineralization is 10 m thick and is traceable for more than 0.5 km along strike toward Rushy Pond. The mineralization at Fox Neck is approximately 30 cm thick and has an exposed strike length of about 10 m.

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GEOLOGIC SETTING AND VOLCANOGENIC SULFIDE MINERALIZATION IN THE EASTERN WILD BIGHT GROUP, NOTRE DAME BAY

by

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INTRODUCTION

The Wild Bight Group comprises a thick sequence of volcanic and sedimentary rocks which outcrops across the central part of Notre Dame Bay between Shoal Arm, Badger Bay and Osmonton Arm, New Bay. The sequence is overlain by fossiliferous Caradocian shale and is considered to comprise part of the Early-Middle Ordovician island arc (e.g. Dean, 1978), remnants of which are widely preserved throughout central and southern Newfoundland.

The eastern part of the Wild Bight Group contains most of the volcanic rocks in the sequence and is host to a number of volcanogenic sulfide deposits, including the Point Leamington, Lockport and Indian Cove deposits and the smaller Long Pond prospect. This report summarizes the results of approximately two months' field work in this area, during which both the regional setting of the Wild Bight Group and the more specific details of the various mineral deposits were examined.

GEOLOGIC SETTING OF THE EASTERN PART OF THE WILD BIGHT GROUP

The general geology of the Wild Bight Group in Notre Dame Bay has previously been outlined by Dean (1978). His stratigraphic nomenclature represents the only published subdivision of the Wild Bight Group and will occasionally be referred to in the following discussion. It seems likely, however, that detailed work in this sequence will require substantial revision of the nomenclature.

A virtually complete cross-section of the Wild Bight Group is exposed on the coastline around Badger Bay and Seal Bay. Well washed exposures provide a good picture of essential features and critical relationships in this area. The principal lithologies can be grouped into three categories: (1) volcaniclastic and sedimentary rocks; (2) volcanic rocks; and (3) intrusive rocks. These are briefly described below. Because of the economic importance of volcanic rocks in the sequence, they are treated in somewhat more detail.

(1) Volcaniclastic and sedimentary rocks:

The Wild Bight Group is dominantly volcaniclastic in nature, consisting of up to 80% sedimentary rocks. These are principally of two types: (1) fine grained, planar bedded, laminated graywacke, siltstone, argillite and chert with local conglomerate beds, and (2) massive, generally unbedded, medium to coarse grained volcaniclastic conglomerate. The latter is generally matrix-supported, often poorly sorted, contains subrounded to angular fragments of locally derived volcanic and sedimentary rocks, and appears to have generally formed as muddy debris flows. The two types are commonly interbedded on a scale of tens of metres and appear to record an environment of relatively quiet sedimentation punctuated by

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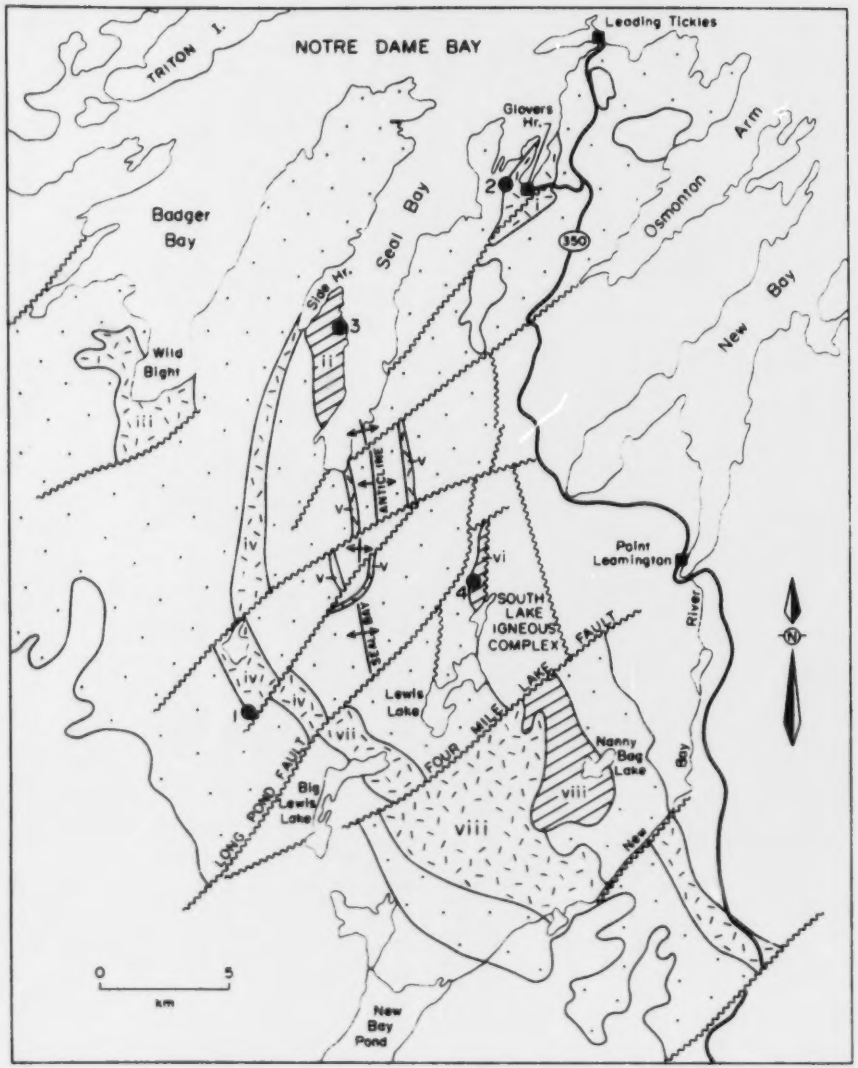

Figure 1: *Simplified geology of the eastern part of the Wild Bight Group.*

LEGEND

Mainly volcaniclastic and sedimentary rocks.

Mainly mafic volcanic rocks.

Mainly felsic volcanic rocks.

KEY TO VOLCANIC SEQUENCES
(see text; most designated names are informal)

i Glovers Harbour basalts.
ii Indian Cove volcanics.
iii Wild Bight, Badger Bay volcanics.
iv Side Harbour formation north of Long Pond fault.
v Sparrow Cove Point formation.
vi Long Pond volcanics.
vii Big Lewis Lake basalts.
viii Volcanic rocks between Four Mile Lake fault and New Bay River

KEY TO VOLCANOGENIC SULFIDE DEPOSITS

1 Point Leamington
2 Lockport
3 Indian Cove
4 Long Pond

periodic turbidity currents and more catastrophic debris flows, probably off the flanks of a nearby volcanic edifice.

Current ripples, crossbeds and slump structures indicate a generally northerly flow, suggesting a topographic high to the south. The geologic environment recorded by those rocks was probably sited on the middle flanks of a volcanic edifice which was situated to the south.

(2) Volcanic Rocks

Volcanic accumulations are present at several localities and various stratigraphic levels throughout the eastern Wild Bight Group (Figure 1). All volcanogenic sulfide deposits in this Group are hosted by volcanic rocks, although not all volcanic accumulations are known to be mineralized. Each major volcanic sequence is briefly described below; designated names for these sequences are for convenience only and do not generally represent formally proposed stratigraphic nomenclature.

(i) Glovers Harbour basalts: The Glovers Harbour basalts, host to the Lockport deposit, have previously been included in the Pennys Brook Formation. They consist dominantly of pillow basalts with lesser basaltic pyroclastics and minor rhyolitic material (probably a single ash flow). They are faulted against well bedded chert, argillite and graywacke to the west and pass conformably upwards into coarse volcaniclastic debris flow deposits. The basalt is always highly vesicular, sometimes intensely cleaved, and appears to occupy a large anticlinal structure, the axis of which trends somewhat east of north through Glovers Harbour.

(ii) Indian Cove volcanics: The Indian Cove volcanics, on the west side of Seal Bay, have previously been assigned to the Seal Bay Brook Formation. They appear to record a small felsic volcanic center consisting mainly of rhyolite, felsic to mafic pyroclastics and lesser pillow basalts, basaltic breccia, laharic debris flows and red chert. This is a very complex geologic unit, both stratigraphically and structurally, with several major folds and rapid facies changes. The specific environment appears to center around a hydrothermally altered rhyolitic dome with associated coarse pyroclastic and slump breccias on the flanks of and overlying the dome. The volcanics apparently pass conformably upward into volcaniclastic graywacke and conglomerate to the west; the eastern contact is not exposed.

(iii) Wild Bight, Badger Bay volcanics: A lens of mafic volcanic rocks has previously been mapped as occupying the bottom of Wild Bight, Badger Bay, with an extension northward along the east shore of Badger Bay (Dean, 1978). Within Wild Bight, these rocks, previously assigned to the Pennys Brook Formation, comprise mainly basaltic, highly vesicular pillow breccias with lesser thin pillowed flows and volcaniclastic units. They are bounded both top and bottom by volcaniclastic rocks and apparently lie near the top of the Wild Bight Group stratigraphy, which is marked by the Caradocian Shoal Arm Formation to the immediate northwest. A previously mapped northeastern extension of these volcanics along the east shore of Badger Bay has been shown by the present mapping to actually comprise green volcaniclastic sandstone and fine grained conglomerate.

(iv) Side Harbour formation north of Long Pond Fault: This is principally a basaltic sequence and hosts Noranda's Point Leamington sulfide deposit. It is well exposed in whaleback outcrops for approximately 3 km south of Side Harbour, and consists mainly of pillow lava, with large (30-50 cm), bulbous pillows which are commonly quite vesicular. The only felsic volcanics noted were in the immediate vicinity of the Point Leamington deposit. The sequence is apparently overlain and underlain more or less conformably by typical Wild Bight volcaniclastic lithologies.

(v) Sparrow Cove Point formation: This sequence is a thin (generally less than 100 m) band of pillowed basalts which are moderately vesicular and outcrop in a horseshoe-shaped belt around the bottom of Seal Bay. This formation is probably misnamed since it does not appear to outcrop at Sparrow Cove Point. However, it is well exposed south of Seal Bay and generally is thin enough that it could well represent a single flow. The basalts are conformably bounded on both sides by laminated chert, siltstone and graywacke.

(vi) Long Pond volcanics: This narrow band of mainly rhyolite, quartz-feldspar crystal tuff, felsic pyroclastic rocks and red chert outcrops in a narrow, north trending band north of Lewis Lake. It hosts the Long Pond prospect and includes a narrow (30-40 m) unit of pillow lava and pillow breccia. It is conformably bounded to the west by red chert and gray to green argillites and faulted to the east against the South Lake Igneous Complex.

(vii) Big Lewis Lake basalts: This sequence outcrops between the Long Pond and Four Mile Lake Faults and is distinguished from the Side Harbour formation basalts which adjoin them to the north in two respects: (1) they comprise mainly pillow breccia and basalt-bearing volcanic breccia with relatively little pillow lava; (2) they pass conformably upward into the Caradocian chert-shale interval and are therefore stratigraphically higher in the section. Both lithologically, and with respect to their stratigraphic position within the Wild Bight sequence, the Big Lewis Lake basalts closely resemble the basaltic sequences in the Wild Bight, Badger Bay section. There are no felsic volcanics in this unit.

(viii) Volcanic rocks between the Four Mile Lake Fault and the New Bay River: Volcanic rocks in this area present the most serious problems with respect to existing maps, which show a relatively large felsic volcanic complex centered on the west end of Nanny Bag Lake surrounded by basalts of the Pennys Brook formation which extend south to the New Bay River.

This study indicates that a thick basaltic sequence is indeed present west of the felsic complex and comprises mainly massive, unpillowed, generally nonvesicular rocks. These are unlike any previously seen in the Pennys Brook formation (or elsewhere in the Wild Bight Group). They are separated from the felsic complex to the west by a thin band of volcaniclastic graywacke and conglomerate which passes conformably eastwards into black to dark blue quartz-eye rhyolite and rhyolitic crystal tuff. The felsic complex seems to contain a considerable amount of volcaniclastic material and at least one, small, coarse biotite granodiorite body west of Nanny Bag Lake which looks Acadian and was previously unmapped. Detailed traversing is needed to fully define the nature of this complex.

At the south end of the volcanic sequence, near the New Bay River, rocks previously mapped as basalt are, at least in part, probably Acadian diorite and gabbro intrusions. To the east of the felsic complex, previously mapped basalts do not appear to be present, as all exposures examined in this area were found to comprise volcaniclastic turbidites. North of Four Mile Lake fault, mafic rocks east of the volcanic sequence look intrusive and may be related to the South Lake Igneous Complex.

(3) Intrusive Rocks

The Wild Bight Group, as previously noted by other workers, is riddled by mafic sills and, less commonly, dikes ranging from fine grained, locally vesicular diabase to coarse grained, equigranular to somewhat porphyritic, gabbro. Fine grained varieties are commonly highly vesicular, locally crosscutting, and sometimes show evidence of intrusion into set

sediments. Most appear to be related to the Wild Bight volcanism and were probably intruded at relatively high levels.

In addition, fine grained lamprophyre dikes are present which cut all lithologic and structural trends and are probably Mesozoic in age (e.g. see Strong and Harris, 1974; Dean, 1978).

VOLCANOGENIC SULFIDE OCCURRENCES

Four principal volcanogenic sulfide occurrences are present in the Wild Bight Group. These were examined in some detail on the ground and, where possible, in drill core. Brief descriptions are presented below:

(i) The Point Leamington deposit: This is the largest single massive sulfide deposit known in Newfoundland and was discovered in the early 1970's by Noranda Exploration Ltd. Previously published dimensions (Noranda staff, 1974) suggest that more than 20 million tonnes of massive sulfide is present, grading approximately 0.5% Cu and 2% Zn with sporadic precious metal values. The area near the deposit is characterized by poor exposure and the massive sulfide body subcrops under a bog. A few footwall exposures of highly altered, pyritic, quartz-eye rhyolitic crystal tuff outcrop immediately east of the deposit and similarly altered and mineralized pillow basalt outcrops about 100 m further east. To the west are unaltered volcaniclastic rocks of the hanging wall. These outcrops summarize the environment; details of the setting are somewhat better displayed in drill core. There is a large alteration zone under the deposit, apparently zoned from a chlorite-rich core to a sericite-silica outer zone, and lower parts of the massive sulfide body have been brecciated and chloritized, apparently by solutions which fed the upper parts. The massive sulfides are uniformly fine grained, dominantly pyritic, with local concentrations of chalcopyrite and sphalerite, remarkably continuous and homogeneous from subcrop to depths in excess of 260 m.

(ii) Lockport: The general geology of the Lockport deposit has previously been outlined in an M.Sc. thesis by DeZoysa (1969). The deposit is hosted by basaltic pillow lavas and minor volcanic breccia and is well exposed in a series of open cuts and dumps from underground workings which date from the early 1900's. No drill core is available.

Mineralized material on the dumps and in the open cuts is massive to heavily disseminated pyrite and chalcopyrite hosted by silicified pyroclastic rocks within the dominantly basaltic sequence. Felsic volcanics are nearby but not obviously spatially related. Exposed mineralization appears to be mainly stockwork, although there is considerable massive pyritic material on the dumps and there may well be an exhalative body associated with the stockwork which was explored underground but does not outcrop. Sulfides are mainly pyrite-chalcopyrite, although sphalerite is locally present, especially in the eastern side of the deposit according to DeZoysa. The deposit appears to face east and to occupy approximately the core of the anticlinal structure which runs up the middle of the Glovers Harbour basalts.

(iii) Indian Cove: The mineralization at the main showing is exposed in several trenches and a small adit. It consists mainly of disseminated and stringer pyrite and chalcopyrite in altered rhyolite and silicic breccia. The mineralized zone is better displayed in drill core from eight holes, presently stored at the western core storage library in Pasadena, which were drilled by Texasgulf in 1975. Examination of this core suggests that the mineralization comprises a stockwork zone with a small, central, intensely altered chlorite-pyrite-chalcopyrite zone surrounded by less intense sericite-silica alteration with abundant py-cpy-(sph) stringers. There does not

appear to be any truly exhalative mineralization in the area of this showing, which appears to be situated just off the flank of a well developed and highly altered rhyolite dome. Alteration associated with the mineralization is extensive and can be traced for several hundred metres in either direction along strike.

(iv) Long Pond Prospect: This prospect lies within a narrow belt of rhyolitic tuff and breccia but is, at least in part, hosted by a thin basaltic pillow lava/pillow breccia unit which can be traced for several hundred metres along strike. The mineralization and accompanying chlorite-sericite-silica alteration is mostly heavily disseminated pyrite and minor chalcopyrite, and is probably stockwork type. This appears to be a good environment and deserves a thorough look for massive mineralization. No drilling has been recorded from this prospect.

CONCLUSIONS

The results summarized in this report are the preliminary phase of a project designed to investigate the geological and tectonic environments of volcanogenic sulfide mineralization in early-middle Ordovician island arc sequences of central Newfoundland. Further work in the Wild Bight Group will focus on petrographic, geochemical and isotopic studies of the volcanic rocks and the associated mineralization. Tentative conclusions reached on the basis of field work to date include:

(1) The Wild Bight Group records a dominantly volcaniclastic environment, punctuated by brief episodes of volcanic activity. It appears to have formed on the middle flanks of a major volcanic edifice which was probably located to the south of the presently preserved sequence.

(2) Volcanic accumulations are locally present at various stratigraphic levels in the sequence. The various volcanic sequences display significant differences in lithology and setting. Within the Wild Bight Group as a whole, volcanism was dominantly mafic, with local development of areally restricted felsic domes and possibly ash flows.

(3) Volcanogenic sulfide mineralization accompanied several of the volcanic episodes. Exhalative sulfides are well developed at the Point Leamington deposit and are underlain by stockwork alteration and mineralization. Mineralization exposed on the surface at the Lockport, Indian Cove and Long Pond prospects (and in drill core from Indian Cove) is mainly of stockwork type. The potential for discovery of related massive mineralization appears to be good in all cases.

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SURFICIAL AND GLACIAL MAPPING OF THE EAST HALF OF THE GREAT GULL POND MAP AREA (12H/1), NEWFOUNDLAND

by

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Introduction

Mapping was conducted in the Great Gull Pond map area during 1983 as a continuation of the Surficial and Glacial Mapping Program in central Newfoundland. The aim of the project is to provide information on the nature and distribution of surficial landforms, the glacial dispersal of rock materials as an aid to mineral exploration, and the significance of mineralized boulders which were discovered to the west of the mine site. The map area has good road access with numerous till exposures, but only a few bedrock exposures exhibiting glacial flow indicators.

Field Program

Field work was started in mid-July and continued until mid-September. Information was obtained along existing roads, lake shorelines and streams as well as from numerous hand-dug or backhoe-dug pits. Three hundred sites were noted and 500 till samples were collected for particle size analysis and geochemistry. A representative pebble fraction (+8mm to -16mm) was obtained at most sites to determine the lithologic composition of the tills. This lithologic study also included silt/clay coating, weathering, staining, sphericity, fracturing, mineralogy and texture for each lithology present.

Stratigraphy

Evidence of glacial stratigraphy in the Great Gull Pond map area is limited to several exposures in the Gullbridge mine vicinity. In a pit near the mine site, a 12 m exposure reveals approximately 2 m of a very sandy ablation till with sandy lenses, overlying 2-3 m of a more compact and silty lodgement till with occasional silty lenses. This till overlies up to 8 m of gravel and sand with some interbedded silty sand and silt, which are underlain by striated bedrock which indicates glacial flow in a northeast direction.

Glacial Striae

Striae in the area record two ice flow directions, the most recent towards the north (350 to 015) and an earlier northeastward flow (030-060). Straie indicating this earlier flow were observed over all of the study area, whereas the northerly flow is evidenced on only a few outcrops.

Conclusions

Glacial dispetsion in the Great Gull Pond area may have been affected by two glacial flows, an early northeastoward flow and a later northward flow. The lodgement till which overlies sand and gravel in the Gullbridge mine area may be related to this later flow or to a more localized advance of ice in the Great Gull Pond area.

The forthcoming analysis of the pebble fraction of the tills, as well as the particle size and geochemical analyses, should provide more information on the glacial history and characteristics of the tills of the area.

Project funded by the Newfoundland Department of Mines and Energy.

ESTIMATION OF PHYSICAL PARAMETERS OF MACLEAN CHANNEL, SULFIDE-BEARING DEBRIS FLOWS, BUCHANS, NEWFOUNDLAND

by

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Subaqueous sulfide-bearing debris flows were the major transport mechanism for the ore units in the MacLean channel. Measurement of the coarse blocky detritus in the flow deposits allows estimation of the yield strength of the debris flows. Paleoslopes can be calculated using the estimated yield strength of the debris. Comparisons between calculated paleoslopes and actual bedding attitudes in the MacLean Extension orebody suggest that present bedding attitudes reflect the paleoslope. Data for the sulfide-bearing debris flows are similar to literature values for non-sulfide flows. Uses of the calculations for mineral exploration include basinal analysis and prediction of locations for high grade debris-flow deposits.

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GEOCHEMISTRY OF GRANITOID CLASTS FROM MACLEAN EXTENSION OREBODY, BUCHANS, NEWFOUNDLAND, AND IMPLICATIONS ON THEIR POSSIBLE SOURCE

by

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The volcanogenic sulfide ore deposits at Buchans, Newfoundland occur as three types: stockwork ore, *in situ* ore, and transported ore. These deposits are hosted by the Buchans Group of the Newfoundland Central Volcanic Belt, an Ordovician-Silurian sequence of subaqueous volcanic, volcaniclastic and sedimentary rocks.

The transported ore forms a series of sulfide-bearing breccia-conglomerate beds with diverse lithic clasts, including granitoid clasts. These beds have been interpreted as being deposited by debris flows. The source of the granitoid clasts has been enigmatic; the Feeder Granodiorite (FG) has been proposed to be comagmatic with the Buchans Group volcanic rocks and the possible source of the granitoid clasts.

Lithogeochemical analyses of the Feeder Granodiorite, a member of the Topsails granite and a suite of granitoid clasts from the MacLean Extension workings have been completed. Comparison of these data permits several points to be raised:

(1) all rocks are silica-oversaturated;
(2) the clasts are subaluminous and the Feeder Granodiorite and Topsails granite are peraluminous;
(3) all rocks are subalkaline, probably calc-alkaline;
(4) the Topsails granite crystallized from an A-type (anorogenic) magma, whereas the Feeder Granodiorite and the clasts from I-type (orogenic) magmas;
(5) trace element data clearly distinguish the Topsails granite from the others, and demonstrate that they cannot be magmatically related;
(6) the magmatic association between the Feeder Granodiorite and the granitoid clasts can be neither established nor refuted with the present data;
(7) the clasts show variable degrees of alteration, probably not related to regional metamorphism.

Petrographic examination, combined with the lithogeochemistry, suggests that the clasts are magma related. A revised classification of the clasts is presented and reflects this perceived association.

Contribution to Canada-Newfoundland co-operative minerals program, 1982-84.
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PRELIMINARY REPORT ON THE MINERALOGY OF THE TULKS MASSIVE SULFIDE DEPOSIT, BUCHANS AREA, NEWFOUNDLAND

by

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The Tulks prospect, held jointly by Price and ASARCO, is a pyritite-type massive sulfide deposit in felsic metavolcanics about 40 km southwest of Buchans. Extensive diamond drilling begun in 1963 has delineated four massive sulfide lenses, designated T-1 to T-4, which total 700,000 to 800,000 tonnes grading about 5.6% Zn, 2.0% Pb, 1.3% Cu, 41 g/t Ag, and 0.4 g/t Au. The T-3 lens has been penetrated by underground workings, from which a bulk sample taken for milling tests gave unsatisfactory metal recoveries. Remnants of the feed for these milling tests and diamond-drill cores from the T-1, T-2 and T-3 lenses have been examined in polished sections to provide a reconnaissance evaluation of the Tulks mineralogy and its pertinence to the metallurgical problems.

Pyrite is the principal sulfide in all of the Tulks lenses, and sphalerite, galena and chalcopyrite account for all but trace amounts of the primary base metal values. Nearly all of the silver contents are attributable to argentian tetrahedrite, and electrum is sufficiently common to account for all of the gold values. Electron microprobe analyses of the sphalerite generally give iron contents of 2 to 3 wt. %, but values up to 8.6% Fe have been obtained for sphalerite in contact with pyrrhotite. Silver contents of tetrahedrite vary up to 10.3 wt. % Ag, and Sb-As values indicate that compositions extend from tetrahedrite to almost end member tennantite. Analyses of two grains of electrum gave 67 and 69 wt. % Au.

In addition to the main sulfides, variable but generally small amounts of arsenopyrite, pyrrhotite, marcasite, magnetite, ilmenite and hematite are present in proportions that are variable from lens to lens. The principal translucent minerals in the massive sulfide zones are quartz, muscovite (some grains containing percentage amounts of BaO), chlorite, barite, calcite and celsian; others present in small amounts are dolomite, rutile, sodic plagioclase, and barium silicates which are as yet unidentified.

The textures and grain sizes of the sulfide minerals are suitable for ore-mineral liberation: most of the base metal sulfides are relatively coarse; finer fractions, even those in compact massive pyritite, are predominantly interstitial to pyrite or along its grain boundaries. Textures are generally simple and grain boundaries are smooth; complex sulfide intergrowths are quantitatively rare. The principal negative factor is that some of the coarse grained pyrite contains small inclusions of galena, sphalerite and chalcopyrite which will not be separable.

Difficulties in processing the Tulks ore seem to be related mainly to supergene alteration and to oxidation of the sulfides, but at this stage of study the superior importance of one versus

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the other has not been established. Supergene alteration is evident from the presence of digenite, accompanied by minor covellite, which occurs in all lenses as thin rinds and hairline veinlets in chalcopyrite and sphalerite. Numerous microscopic masses of marcasite alteration are present in the T-1 and T-2 lenses, but have not yet been found in the incompletely studied T-3 lens. Oxidation of the sulfides is evident from goethite rims around voids, indistinct peripheral alteration of galena (to cerussite?), and in some cases the local presence of abundant anglesite. Supergene and oxidation effects are not continuous across the thickness of a lens, and more work is needed to establish the extent of these alterations.

GEOPHYSICAL MEASUREMENTS AT BUCHANS

by

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A variety of surface and borehole geophysical measurements were carried out at Buchans, Newfoundland, during the period August 1982 to March 1983. These included: mise-a-la-masse, IP/resistivity, gamma-ray spectrometry, and Pulse EM techniques in boreholes and deep penetration EM techniques on the surface. These studies were conducted to evaluate the usefulness of the above techniques for outlining the mineralization and to evaluate their potential usefulness in the search for new ore in the Buchans area.

Drill hole mise-a-la-masse, IP/resistivity and natural gamma-ray spectrometry measurements were carried out over three prospects at Buchans. The mise-a-la-masse potential and IP measurements were conducted underground in the MacLean Extension orebody. Two drill holes at the Mudhole prospect and one at the Clementine prospect were logged with IP/resistivity and gamma-ray spectrometry.

The sulfide mineralization in the MacLean Extension, with high conductivity relative to the host rock, was easily traced from hole to hole with the mise-a-la-masse technique. Drill hole resistivity logs over the Clementine prospect indicate that the conductivity contrast between the mineralization and the host rock is low, making this type of mineralization a poor target for surface electrical and EM techniques. Examination of the raw gamma-ray spectral logs indicates that this may be a useful technique for characterizing the lithology in volcanic settings.

Deep electromagnetic surveys with Maxi-probe and Geonics EM-37 systems were carried out at two sites near Buchans, Newfoundland, during the summer of 1982. The first test site was over the Clementine prospect, which is an irregular sulfide body rich in spalerite and barite at a depth of about 300 m from the surface. Because of the low conductivity of the orebody and great depth, the EM response on the ground was very weak. It is doubtful whether processing will improve the signal/noise ratio in data from this area.

The second text survey area was at Mary March, about 24 km from Buchans, where several shallow sulfide boulders have been found in the past. The EM survey located several weak conductors in the area, but it is not clear whether the weak response is due to the small size of the bodies or their poor electrical conductivity contrast with the country rock.

Experimental borehole Pulse EM surveys were also carried out in selected locations to determine whether the technique could detect new orebodies in the Buchans geologic setting. Primarily due to the absence of suitable open boreholes for these tests, results are inconclusive. However, further analysis of these data is in progress to evaluate the significance of some very subtle responses recorded in the measurements.

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THE TOPSAILS IGNEOUS TERRANE OF WESTERN NEWFOUNDLAND

by

J.B. Whalen* and K.L. Currie*

Introduction

The approximately 9000 km^2 area of west-central Newfoundland covered in our study includes portions of Red Indian Lake (west half) (12A/11, 12, 13, 14 and 15), Red Indian Lake (east half) (12A/15 and 16), Sandy Lake (west half) (12H/3) and Sandy Lake (east half) (12H/1, 2, 7 and 8) map sheets. Work on the Topsails igneous terrane, carried out between 1981 and 1983, has been published previously (Whalen and Currie, 1982, 1983a,b). The preliminary geological map from Whalen and Currie (1983a) is given in Figure 1.

Geology

The Topsails igneous terrane exhibits a complex sequence of intrusive relationships. There is in general (a) an almost total lack of sedimentary and regionally metamorphosed rocks, (b) generally massive igneous rocks, and (c) a predominance of potassic and leucocratic granitic rocks. All these characteristics differ strongly from those of juxtaposed terranes. The Topsails terrane consists of a core of various massive, high level, pink to red granite and porphyry plutons separated and fringed by screens of older rocks. It appears to be separated from neighboring terranes by major tectonic breaks which have, in some cases, been affected by later igneous activity. In the northwest, the drift-filled valley of Birchy Lake, thought to contain the Lobster Cove fault, separates the Topsails and Fleur de Lys terranes. To the west, a steeply dipping fault, exposed in Conners Brook and thought to extend the length of Grand Lake (Hyde and Ware, 1981), separates the Topsails terrane from a Carboniferous basin. To the south and east, investigations in the Buchans camp (Thurlow, 1981), and our own observations further to the southwest, indicate that the Topsails terrane is thrust to the southeast over the central volcanic belt of Newfoundland, and over a gneissic, much more mafic, igneous terrane to the south of Lewaseechjeech Brook.

Rocks of the map area probably range in age from Precambrian to Pennsylvanian, with most if not all the intervening periods represented. Detailed descriptions of the map units in Figure 1 are given in Whalen and Currie (1983a,b).

Recent work (Whalen and Currie, *in press*) has indicated the presence of massive to strongly sheared and metamorphosed alkaline to peralkaline granites in the Hare Hill area, south of Grand Lake. These granites strikingly resemble the massive, undeformed, unmetamorphosed, alkaline to peralkaline granites of the Topsails igneous terrane. If the

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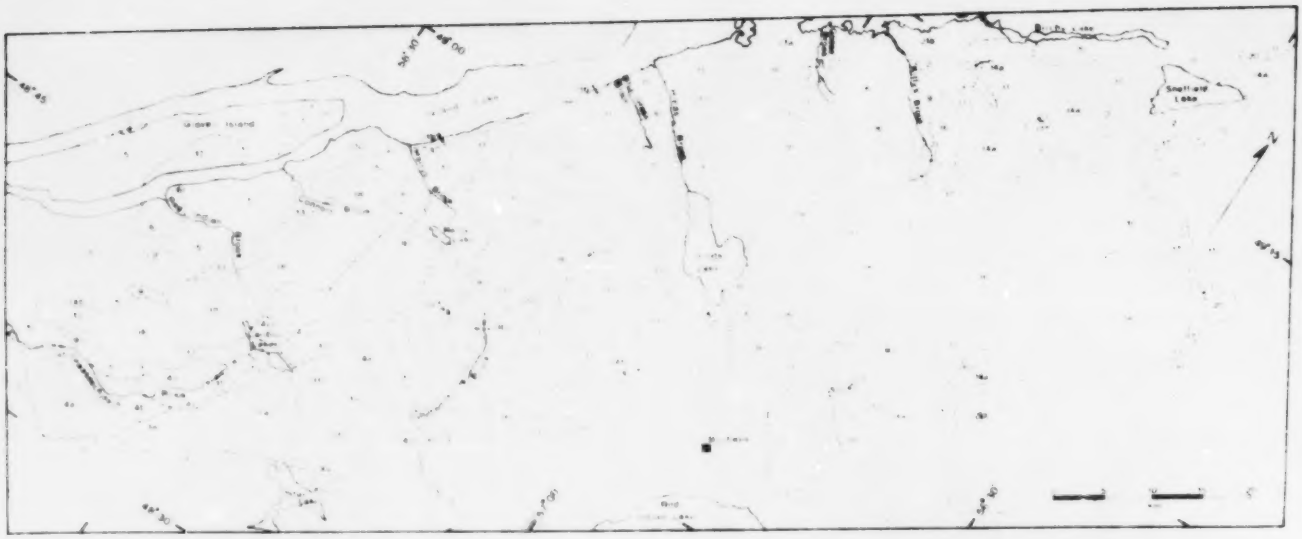

LEGEND

Period	Unit	Description	Symbol
Carboniferous	Hawley Beds	Grey sandstone, minor conglomerate and siltstone	21c
	Little Pond Brook Formation	Grey to green muscovitic sandstone, quartz pebble conglomerate	21b
	North Brook and Rocks Brook Fms.	Pink to orange conglomerate and sandstone, granite wash	21a
	unconformity		
Devonian (?)		Quartz feldspar porphyry, rhyolite, minor basalt, composite dykes	20
	relations uncertain		
		diabase and porphyry dykes	19
	intrusive contact		
		Massive white biotite-amphibole, two feldspar granite	18
	gradational to intrusive contact		
		fine- to medium-grained amphibole + pyroxene, amphibole-biotite and biotite one or two feldspar granites and minor granodiorite (marginal and contaminated phases of unit 16)	17
	intrusive to gradational contacts		
		coarse white to red amphibole + pyroxene, one feldspar granite	16
	intrusive contact		
		pink biotite-amphibole two feldspar granite	15
	relations uncertain		
Silurian (?)		red amphibole biotite syenite to granite	14a
		grey to orange amphibole + pyroxene gabbro to syenite	14b
	relations uncertain		
		agmatite of mafic to ultramafic blocks in granitoid matrix. Blocks may be as old as unit 1. Matrix may be as young as unit 18	13
	intrusive to gradational relations		
		red epidotized and chloritized granophyric aplite	12
	intrusive to gradational relations		
	Springdale Group (?)	red rhyolite, rhyolite breccia, laharic breccia, minor subaerial basalt	11
	unconformity		

Period	Unit	Description	Symbol
Ordovician (?)		pink biotite (-muscovite) granite and aplite	10
	relations uncertain		
		pink biotite-amphibole potash feldspar porphyritic, two-feldspar granite	9
	relations uncertain		
	Feeder Granodiorite	pink to red, biotite-amphibole, two feldspar granite	8
	intrusive contact		
	Buchans Group	basalt, rhyolite, tuff, breccia, minor subaqueous conglomerate	7
	relations uncertain		
	Rainy Lake complex	gabbro, diorite, minor granodiorite; may be equivalent to 5 in part	6
	intrusive contact		
	Clover Formation	pillow, basalt; massive basalt, minor rhyolite; tuff and shale. Probably equivalent to 7 in part	5
	mainly tectonic contacts		
		massive to moderately foliated granodiorites with many small mafic to ultramafic fragments. Relations between subunits uncertain 4a biotite granite to granodiorite, minor amphibole granodiorite 4b amphibole-biotite quartz-eye porphyritic granite to granodiorite 4b white amphibole granodiorite 4d biotite-muscovite granodiorite and migmatite	4
	relations uncertain		
		hornblende-biotite tonalite to diorite moderately to strongly foliated, with many small to large mafic to ultramafic inclusions	3
	relations uncertain		
	Hungry Mountain complex	hornblende gabbro, diorite, tonalite, amphibole-biotite granodiorite, minor biotite-muscovite gneiss, moderately to strongly foliated with many small to large mafic inclusions. Probably equivalent to units 3, 4	2
	intrusive to gradational relations		
		mafic to ultramafic rocks; basalt, gabbro hornblendite, ophiolitic suites	1

Geology by J.B. Whalen 1981, 1982, K.L. Currie 1981, 1982, J.G. Graves 1981, and P. Barrette 1982

Figure 1 ***Preliminary geological map of the Topsails igneous terrane.***

Hare Hill terrane represents a deformed equivalent of the Topsails terrane, the implications for the tectonics of western Newfoundland are profound. The locations of the Cabot Fault and Baie Verte - Brompton Line must be reconsidered and all Newfoundland ophiolites cannot be made to lie near the same zone of generation. Clarification of the nature and timing of the post-Silurian tectonothermal event which affected the Hare Hill terrane may require reinterpretation of the tectonics of this region. The existence of Grenvillian basement in the form of anorthosite and granulites in the Hare Hill terrane suggests that continuous Grenville basement may form the substrate of the Humber Zone and the Topsails terrane.

Economic Geology

The volcanogenic massive sulfide deposits of the Buchans camp have been among the most economically important mineral deposits in the province of Newfoundland, yielding 15,813,000 tonnes of ore with an average grade of 14.62% Zn, 7.60% Pb, 1.34% Cu, 114.77 g/t Ag and 1.34 g/t Au (Thurlow and Swanson, 1981). All the economic deposits in the area occur in the Buchans Group (Unit 7) and belong to three related types: (1) stockwork ore, (2) *in situ* syngenetic massive sulfide ore, and (3) mechanically transported breccia ore. The Glover Formation (Unit 5) and the Buchans Group both contain considerable volumes of pillow lava, and we have mapped volcaniclastic sediments and rhyolites in Unit 5. Since the Glover Formation seems to be of similar age to the Buchans Group, and contains probable island-arc-type intrusions, we suggest that it, like the Buchans Group, has potential for island-arc-type massive sulfide mineralization.

The Topsails terrane has received little prospecting attention, presumably due to its relative remoteness and poorly known geology. However, we believe that some units have significant economic potential. There is a similarity between the Rainy Lake complex (Unit 6) and also the tonalite terrane (Unit 3) and recent island arc intrusive suites. Such intrusions have known potential for porphyry copper and also gold mineralization. Some fracture fillings of quartz plus pyrite, chalcopyrite and molybdenite have been noted in the Rainy Lake complex. Biotite-muscovite granite west of Hinds Lake (Unit 10) has numerous pegmatitic to aplitic zones with patchy muscovite alteration. Also, within Unit 4 at the southeast edge of the Topsails terrane, there are cordierite- and sillimanite-bearing biotite-muscovite granite and granodiorite. Since these granites are clearly S-type in the classification of Chappell and White (1974), and Unit 10 exhibits greisen-like alteration, we suggest that the granites have potential for Sn mineralization.

The younger supracrustal rocks of the Springdale Group (Unit 11) are subaerial in origin, and therefore lack potential for massive sulfide mineralization. Both the rhyolite and genetically related aplite (Unit 12) contain vuggy fracture fillings of fluorite and rare topaz in the central part of the Topsails terrane. We consider there to be potential for other vein-type base and precious metal mineralization in these rocks.

North of Cariboo Lakes, there is a showing consisting of coarse grained (1 to 2 cm) molybdenite rosettes in a drusy matrix of granophyric aplite belonging to Unit 17. The host rocks and the mode of mineralization closely resemble molybdenite showings in the Ackley City Batholith (Whalen, 1980). The diverse fine grained phases (Unit 17) associated with the amphibole granite (Unit 16) probably represent marginal and high level phases, as is the case for the Ackley showings, and have potential not only for Mo but also for other elements, such as Sn and F, concentrated in highly fractionated granitic magmas. It is notable that in

the area southwest of Hinds Lake, fine grained, high level phases of Unit 17 predominate, and geological relationships between intrusive units are more complex. The area northeast of Hinds Lake, however, is dominated by large ovoid plutons of coarse grained amphibole granite (Unit 16). We interpret this feature as indicating a deeper level of erosion of the granites northeast of Hinds Lake, brought about by uplift associated with block-faulting. The area southeast of Hinds Lake has greater economic potential, for it is well known that granite-related mineralization is concentrated in the roof zones or cupolas of granite magma chambers.

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South Coast of Newfoundland

GEOLOGY OF THE WEST HALF OF THE DOLLAND BROOK MAP AREA (11P/15), NEWFOUNDLAND

by

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The west half of the Dolland Brook (11P/15) area was mapped on a 1:50,000 scale during the 1983 field season; the east half was completed by Dickson and Delaney *(this volume)*.

The Dolland Brook map area is sited in the eastern part of the Hermitage flexure (Williams et al., 1970), a generally east trending, sinuous configuration of rock units that occurs along the south coast of Newfoundland. The metasedimentary and metavolcanic rocks are included in, and are westwardly continuous with, the Bay du Nord Group (Cooper, 1954; O'Brien and Tomlin, *this volume*). They are also the probable equivalents of the Baie d'Espoir Group (Jewell, 1939; Colman-Sadd, 1974) to the east.

Rock units in the west half of the Dolland Brook area may be grouped into three broad subdivisions:

(1) a central wedge of metasedimentary and metavolcanic rocks of the Bay du Nord Group,

(2) a southern zone of migmatite and foliated granitoids, and

(3) a northern area of little deformed biotite granite and two-mica granite (North Bay Granite).

The Bay du Nord Group (Units 1-5) consists of five lithostratigraphic units whose outcrop pattern is mostly controlled by a moderately west plunging F_2 syncline, nicely outlined by a narrow band of felsic volcanics (Unit 3). Unit 1 consists predominantly of pelite, semipelite and psammite with minor amphibolite, graded sandstone and quartz-pebble conglomerate. These rocks occur mostly in the thermal aureole of the North Bay Granite; biotite, muscovite, garnet, andalusite and hornblende porphyroblasts are profuse. Unit 2 is interpreted as the higher grade metamorphic equivalent of Unit 1, containing many leucogranite veins and migmatite. Unit 3 is a narrow band of fine grained felsic tuff that is pinkish to grayish white weathering. Locally, quartz and feldspar "eyes" occur. The volcanics are structurally and stratigraphically overlain by fine to coarse grained sandstone, siltstone and conglomerate, including quartz-pebble conglomerate, of Unit 4. These clastics grade into gray and black slates of Unit 5 that occupy the core of the F_2 syncline. A pronounced penetrative foliation (S_1) is developed throughout these rocks, and is axial planar to small scale F_1 folds. A variably developed strain-slip cleavage(S_2) axial planar to second phase folds, locally producing Type III interference patterns.

Areas of migmatite (Unit 6) consisting of crudely banded granitoid with minor pelitic and amphibolitic inclusions occur in the southern granitoid terrain. Unit 7 forms part of that terrain and consists of coarse grained feldspar-megacrystic biotite granite that becomes progressively mylonitized toward a mylonite zone along its southern border. Most of the southern granitoid zone is underlain by medium to coarse grained, equigranular to porphyritic biotite granite (Unit 8). A regional, moderately to strongly devel-

Contribution to Canada-Newfoundland co-operative minerals program 1982-84. Project financed by the Newfoundland Department of Mines and Energy.

Figure 1: *The geology of the west half of the Dolland Brook map area (11P/15).*

LEGEND

DEVONIAN AND EARLIER

North Bay Granite (Units 10 and 11)

11 Medium to coarse grained, equigranular to coarsely porphyritic biotite-muscovite granite; includes minor biotite granite.

10 Medium to coarse grained, equigranular to coarsely porphyritic biotite granite; includes minor two-mica granite.

9 Fine grained, equigranular, minor biotite - rare muscovite granite.

8 Medium to coarse grained, equigranular to finely porphyritic biotite granite.

7 Coarse grained, coarsely porphyritic biotite - minor hornblende granite.

ORDOVICIAN(?)

6 Crudely banded granitoid and migmatite with minor pelite and amphibolite inclusions.

Bay Du Nord Group (Units 1-5)

5 Gray to black slate/phyllite; locally contains thin siltstone and fine grained sandstone beds.

4 Sandstone, siltstone and slate locally containing pebble to cobble conglomerate, including quartz-pebble conglomerate.

3 Fine grained felsic tuff, minor quartz-feldspar lapilli tuff and minor volcanic breccia; locally contains interbedded graphitic pelite.

2 Pelitic and semipelitic schist and migmatite with concordant leucogranite veins.

1 Psammite, semipelite and pelite with minor sandstone, conglomerate, graphitic pelite, and amphibolite.

SYMBOLS

Geological contact (defined, approximate, assumed).....

Bedding, tops known (inclined, overturned).....

Bedding, tops unknown (inclined, vertical).....

Regional cleavage, schistosity, S_1 (inclined).....

Crenulation or strain-slip cleavage, S_2 (inclined, vertical).....

Minor F_2 fold axes.....

Large scale F_2 fold (syncline).....

Mylonitic foliation (inclined, vertical).....

Migmatitic banding (inclined, vertical).....

Weak to moderate biotite alignment (inclined).....

Fracture cleavage (inclined).....

Mylonite zone.....

oped foliation locally merges into mylonite zones. Fine grained biotite granite of Unit 9 is the latest granite in this area.

The northern granitoid terrain is underlain by the North Bay Granite (Jewell, 1939), represented by two phases in the map area. The earlier phase is a medium to coarse grained, porphyritic, biotite-rich granite (Unit 10) that largely occurs along the southern margin of the intrusion. A later two-mica phase (Unit 11) contains variable amounts of muscovite and is commonly porphyritic. Dikes of similar composition intrude the biotite-rich phase. Locally a weak mica alignment and/or a fracture cleavage are developed.

Disseminated pyrite is common in rusty weathering felsic volcanics (Unit 3) east of Salmon River. Pyrite gossan occurs locally in thin tuff bands interbedded with Unit 5 slates and disseminated pyrite or pyrite cubes are common throughout the slates. A number of scheelite occurrences associated with the North Bay Granite contact were shown on maps prepared for the Buchans Mining Company (Scott and Conn, 1950).

In summary, the Bay du Nord Group in the Dolland Brook area probably represents a turbidite sequence with distal submarine felsic volcanism. Regional deformation and metamorphism resulted in recumbent F_1 folds, possibly during the intrusion of synkinematic granites in the southern terrain. Developing mylonite zones or renewed movement along existing ones occurred at this time. The relatively undeformed granite in the north postdated these events and may have contributed to the shortening that produced the F_2 folds.

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GEOLOGY OF THE COLD SPRING POND MAP AREA (WEST PART) 12A/1, NEWFOUNDLAND

by

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Introduction

The eastern part of the Cold Spring Pond area has been mapped in previous years by Swinden and Collins (1982) and Colman-Sadd (1983). The accompanying map shows the whole area, but only units that occur in the western part and have been the subject of mapping during 1983 are discussed below. The boundary between this year's work and previous work coincides with the fault running south through Cold Spring Pond and, in the southern part of the area, with the easterly extent of the Spruce Brook Formation and related units.

The geology of the area is divisible into five tectonostratigraphic components:

(1) Ophiolitic rocks (Units 1-3) and volcanic and sedimentary rocks of the Baie d'Espoir Group (Units 8-15). These rocks probably span the time interval from Cambrian to Middle Ordovician.

(2) Sedimentary and volcanic rocks of the Spruce Brook Formation(?) and related units (Units 4-7) of probable Early to Middle Ordovician age.

(3) Sedimentary rocks at Dolland Pond of possibly Silurian age.

(4) Granite, migmatite and associated high grade metamorphic rocks. The time of intrusion was probably Devonian.

(5) Gabbro/diorite, possibly of Devonian age.

Structural Framework

The division of component 1 into two parts on the map legend arises from the structural interpretation of central Newfoundland outlined by Colman-Sadd and Swinden (1982). This interpretation, which is based on evidence in the Burnt Hill (2D/5), Miguels Lake (2D/12) and Great Burnt Lake (12A/8) areas, proposes that rocks of component 1, representing typical Dunnage Zone sequences, occur as an allochthonous sheet on rocks of component 2 (Spruce Brook Formation, etc.) and probably also the less mobilized parts of component 4 (granites and migmatites). Thus, although the two components are distinct lithologically and tectonically, they are interleaved on the map legend which is purely descriptive and ordered only by age.

Using the structural interpretation of an allochthonous Dunnage Zone, a tentative explanation of the outcrop pattern can be given. Rocks of the Baie d'Espoir Group are locally bordered by ophiolitic rocks which are thought to have been their original basement. The ophiolitic rocks now form the lowest unit, only sporadically preserved, of the component 1 overthrust sheet, and are in contact with the structurally underlying rocks of the Spruce Brook Formation. The abrupt narrowing of the Baie d'Espoir Group westward across the Cold Spring Pond Fault implies that the country to the west was upthrown on the fault and that a deeper level ofthe crust is exposed. Likewise, exposure of Spruce Brook Formation and granite and

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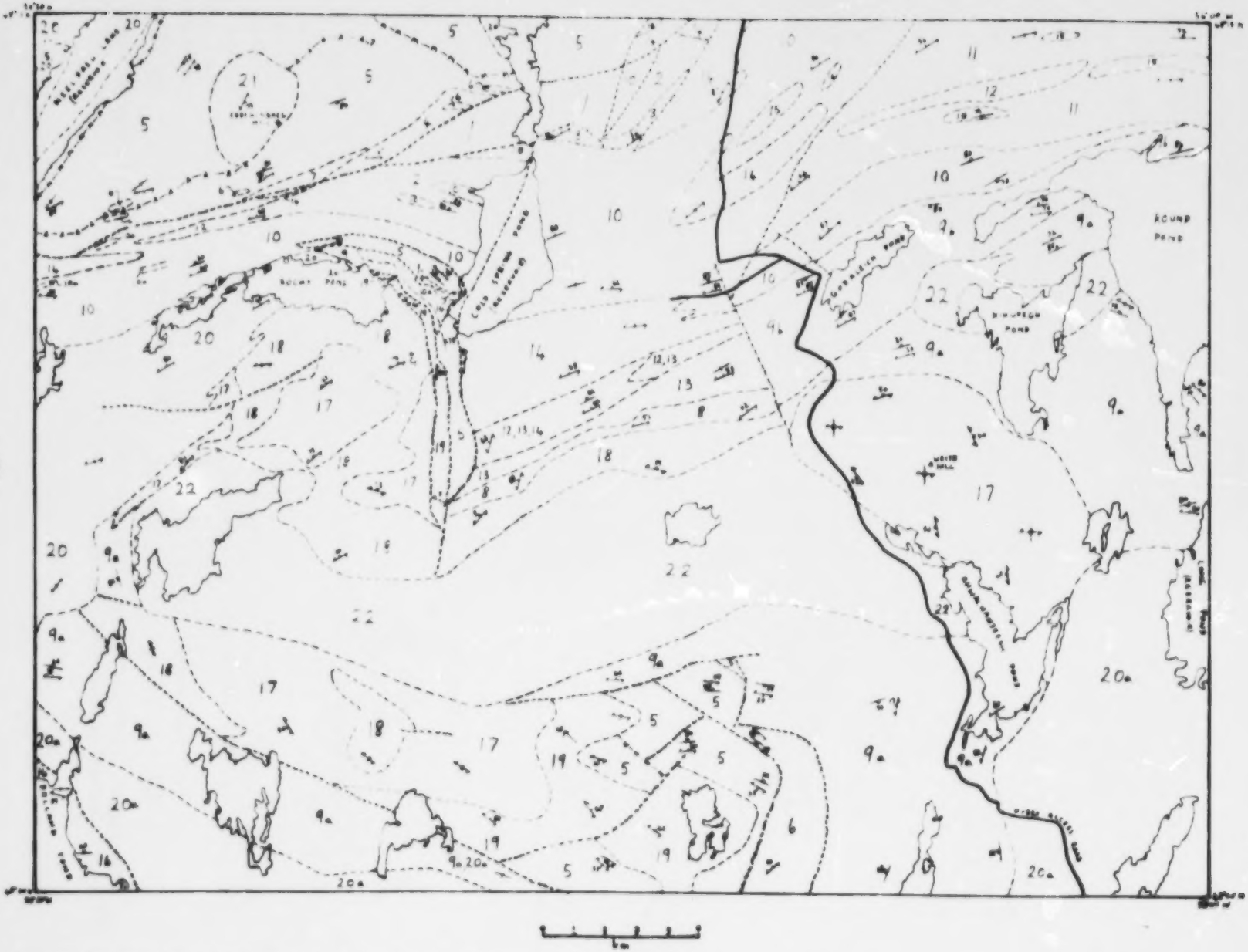

Geology of the Cold Spring Pond (12A/1) area, compiled from field work done during 1983 and from the reports of Swinden and Collins (1982) and Colman - Sadd (1983).

LEGEND

DEVONIAN or older

22 Gabbro, diorite and minor granodiorite.

21 Medium to fine grained, equigranular, lineated or foliated biotite granite.

20 Equigranular to porphyritic, medium to coarse grained, moderately foliated biotite or biotite-muscovite granite. Includes North Bay Granite **(20a)**.

19 Strongly foliated, megacrystic biotite granite.

18 Diffusely banded, medium to fine grained muscovite-biotite granite, with abundant xenoliths of schist and psammite.

17 Well foliated, medium to coarse grained migmatite, with schlieren structure; locally includes non-migmatitic sillimanite schist.

SILURIAN (?)

16 Thin to medium bedded, moderately cleaved, dark greenish gray sandstone and shale.

LOWER TO MIDDLE ORDOVICIAN

Baie d'Espoir Group (Units 8-15) (no stratigraphic order implied by sequence)

North Steady Pond Formation and related units

15 Matic pillow lava, massive basalt, pillow breccia. Includes considerable fine grained chloritic tuff and lesser fine grained sediments.

14 Silicic pyroclastic rocks: dark green to black, siliceous tuff with abundant quartz crystals and local concentrations of feldspar crystals and/or lithic fragments; locally associated with limestone.

13 Dark green, thinly bedded phyllite.

12 Conglomerate: polymictic, unstratified to poorly stratified boulder and pebble conglomerate; commonly matrix-supported and poorly sorted.

11 Silicic tuff and reworked tuff, quartz and feldspar crystal tuff and crystal-lithic tuff; commonly unstratified but locally shows evidence of reworking.

10 Sedimentary rocks: includes gray to green, thick to thin bedded, arkosic sandstone, siltstone and laminated phyllite, with local black, graphitic argillite **(10a)**.

9 **Salmon River Dam Formation.** Dark purplish gray siltstone and very fine grained sandstone, with minor calc-silicate, pelitic and quartzitic beds. **9a**, mainly medium to thick bedded; **9b**, thin bedded.

8 Psammitic schist with quartz and granite sweats.

Spruce Brook Formation(?) and related units (Units 4-7) (no stratigraphic order implied by sequence)

7 Conglomerate composed mainly of quartzite clasts.

6 Felsic crystal tuff and subvolcanic(?) granite.

5 Interbedded quartzite and pelite; metamorphic grade varies from greenschist facies to migmatite; -----A----A, first appearance of andalusite; ----M----M, beginning of melting.

4 Pelitic and semipelitic phyllite and schist.

CAMBRIAN TO LOWER ORDOVICIAN

3 Basalt: pillowed to massive flows, commonly variolitic; pillow breccia; minor tuff.

2 Coarse to medium grained gabbro and trondhjemite, with minor pyroxenite.

1 Peridotite, fine grained, commonly with pyroxene phenocrysts and disseminated chromite.

migmatite between Dolland and Ahwachanjeesh Ponds implies uptaulting of these rocks relative to the surrounding Salmon River Dam Formation of the Baie d'Espoir Group.

Component 1: Ophiolitic Rocks and the Baie D'Espoir Group

Ophiolitic rocks west of Cold Spring Pond consist exclusively of serpentinized peridotite. In the northern outcrop contacts are presumed to be faulted, whereas in the southern one, between Rocky Pond and Cold Spring Pond, there is actual exposure of the faulted relationship of the serpentinite to Baie d'Espoir Group in the south and Spruce Brook Formation in the north.

The rock types of the Baie d'Espoir Group west of Cold Spring Pond are described in the map legend. The conglomerate unit is abruptly terminated by the Cold Spring Pond fault and cannot be matched across the pond. A small amount of pyrite mineralization was found in felsic crystal tuff and associated exhalative limestone in the brook between Rocky and Cold Spring Ponds.

In the southern part of the map area, the Baie d'Espoir Group is represented by the Salmon River Dam Formation. This formation can be observed to have a conformable relationship with rocks of Unit 10 northwest of Godaleich Pond and is thought to underlie them (Colman-Sadd, 1980).

Rocks of component 1 generally have one penetrative cleavage that has been sporadically crenulated by a second deformation. The metamorphic grade is greenschist facies except close to contacts with the granite intrusions of Unit 20 where it is somewhat higher and migmatization has taken place locally.

Component 2: Spruce Brook Formation(?) and Related Units

Rocks provisionally included in the Spruce Brook Formation in the Cold Spring Pond area consist mainly of interbedded quartzite and pelite at various grades of metamorphism. They are similar to rocks exposed in the Burnt Hill (2D/5), Miguels Lake (2D/12) and Great Burnt Lake (12A/8) areas (Colman-Sadd and Swinden, 1982) which contain Lower to Middle Ordovician fossils. The formation outcrops in four separate parts of the Cold Spring Pond area.

In the northern outcrop around Ebbegunbaeg Hill, three additional lithologic types are present. These are areas of pelite without accompanying quartzite beds, conglomerate formed almost entirely of quartzite pebbles, and felsic crystal tuff. The tuff is particularly important because the Spruce Brook Formation has hitherto been characterized by an absence of volcanic rocks or obvious volcanic detritus. It occurs in sharply bounded lenses that do not seem to grade or shed any detritus into the surrounding sediments. A further feature of the northern outcrop is the presence of mafic dikes which in the high grade rocks near Meelpaeg Lake become sheets of amphibolite. The northern outcrop is considered to be faulted against the Baie d'Espoir Group because part of the contact is marked by ultramafic rocks, a marked topographic lineament extends west from the ultramafic outcrop, and there is an inconsistency of units along the contact suggesting tectonic truncation. Metamorphism in the northern outcrop varies from greenschist facies up to migmatite and seems to be spatially related to the granite of Unit 20.

The outcrop just west of Cold Spring Pond is in exposed fault contact

with ultramafic rocks on its south boundary, but is unexposed on its north boundary. The outcrop south of Cold Spring Pond cuts across the strike of the Baie d'Espoir Group rocks to the east and is bounded to the west by sheared and mylonitized granite. Both outcrops are metamorphosed in the greenschist facies.

At the southern edge of the map area the Spruce Brook Formation is in exposed fault contact with the Salmon River Dam Formation, and has probably been intruded by foliated granite of Unit 19. The formation consists entirely of quartzite and pelite at andalusite, sillimanite and migmatite grades. Felsic crystal tuff and granite of Unit 6 are tentatively included in the map legend as associates of the Spruce Brook Formation. The contacts, however, are faulted and it is possible that they actually form part of the Baie d'Espoir Group. A grab sample of the crystal tuff contains disseminations of probable stibnite.

The Spruce Brook Formation and related units have a dominant penetrative cleavage. This cleavage, however, has irregular trends that strongly suggest the presence of important large scale second deformation structures, and in several exposures a second cleavage is visible.

Component 3: Sedimentary Rocks at Dolland Pond

Several exposures of dark green sandstone and shale (Unit 16) are associated outside the Cold Spring Pond area with polymict conglomerate. The conglomerate was likened by Williams (1970) to the Silurian Goldson Formation, and the sandstone and shale bears a striking resemblance to rocks of the Silurian Botwood Group in the West Gander Rivers area (2D/11) (Blackwood, 1981; Colman-Sadd, 1982). The rocks have a single penetrative cleavage and are metamorphosed in the greenschist facies. Their contacts with the North Bay Granite are assumed to be faulted because of the relatively low metamorphic grade and the absence of granite veins.

Component 4: Granites, Migmatites and Related Rocks

Granitoid rocks of the Cold Spring Pond area fall into four groups. Probably the oldest of these is the spectrum from sillimanite schist, through migmatite, to fine grained granite represented by Units 17 and 18. The granite end-member of these two units is a rusty weathering, medium to fine grained rock, crowded with xenoliths of biotite schist and psammite. Locally it also contains sheets and xenoliths of the Salmon River Dam Formation, and just southwest of Cold Spring Pond a huge block of peridotite is present completely surrounded by granite and migmatite.

Strongly foliated biotite granite of Unit 19 is coarse grained and in many places megacrystic. It has intruded migmatite of Unit 17 and Spruce Brook Formation of Unit 5 and has been emplaced along the Cold Spring Pond fault as a cataclastically deformed and locally mylonitized tectonic slice. In the southern part of the area the strong first deformation fabric has been tightly folded by a second deformation, the outcrop pattern may reflect this period of folding.

Equigranular to porphyritic granite of Unit 20 forms part of the North Bay Granite batholith and associated intrusions. In contrast to granite of Unit 18, it contains few xenoliths and has sharply defined intrusive contacts. It has intruded rocks of the Baie d'Espoir Group and Spruce Brook Formation as well as the granite and migmatite of Units 17 and 18. Metamorphic isograds in both the Baie d'Espoir Group and the Spruce Brook Formation appear to be largely controlled by this granite.

Biotite granite of Unit 21 is medium to fine grained, locally has quartz megacrysts, and has been cut by a few quartz porphyry dikes. Much of the intrusion has a strong steep lineation or foliation and it has deflected structures in the country rocks. It has not, however, had any metamorphic effect on the country rocks.

Component 5: Gabbro/Diorite

Medium grained hornblende gabbro and quartz-biotite-hornblende diorite (Unit 22) form an intrusion that cuts the Salmon River Dam Formation and the granite and migmatite of Units 17 and 18. The gabbro is only very locally foliated and the outcrop does not appear to be offset by the Cold Spring Pond fault. For these reasons, the time of intrusion is considered to be relatively late in the development of the geology of the area.

Mineral Potential

Small showings of sulfides have been found in felsic pyroclastic rocks of Unit 14 just west of Cold Spring Pond (pyrite), and of Unit 6 at the south edge of the area (stibnite?). These volcanic rocks probably have the greatest potential for economic mineral deposits in the part of the area described in this report.

Granite of Unit 20 has yielded no indication of mineralization within the map area, but lake sediment surveys have identified tungsten anomalies just to the south, apparently within the same intrusion (Davenport and Butler, 1982).

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WHITE BEAR RIVER (11P/14), NEWFOUNDLAND: Preliminary Report

by

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Introduction

The White Bear River map area, centered approximately 45 km northeast of Burgeo, is located along the northern reentrant of the Hermitage Flexure (Williams *et al.*, 1970) and contains elements of the Gander and Dunnage Zones of the Appalachian Orogen. The northern part of the area is underlain mainly by an east to east-southeast trending belt of polydeformed metasedimentary, metavolcanic and ophiolitic intrusive rocks, which is continuous with the Ordovician Bay du Nord and La Poile Groups (Cooper, 1954; Chorlton, 1980; O'Brien, 1983) to the west, and which is in part considered correlative to the Middle Ordovician Bay d'Espoir Group (Jewell, 1939; Colman-Sadd, 1976) to the east. In the White Bear River area, the Bay du Nord and La Poile Groups and the underlying ophiolitic rocks are intruded by syn- to late tectonic granitoids of the Burgeo batholith (Williams, 1978; O'Brien, 1983) to the south. The Bay du Nord Group is also intruded by the North Bay Granite in the northeast and by several smaller syntectonic and late tectonic granites that are geographically separate from the larger granitoid plutons.

Geology

The oldest rocks in the area are layered and massive gabbro, diabase, pyroxenite and minor dunite (Unit 1) exposed in an elongate, 15 km^2 roof pendant in the Burgeo batholith. The association of gabbro with pyroxenite and dunite strongly indicates that these rocks are of ophiolitic origin. In the adjacent Peter Snout area (O'Brien, 1983), boulders of lithologies identical to Unit 1 are widespread in thick conglomerate beds in the basal parts of the Bay du Nord Group, suggesting that the group may have, at least locally, formed upon oceanic crust. The Bay du Nord Group (Units 2 to 6) consists of a variety of mafic (Unit 2) and predominantly felsic (Unit 3) volcanic rocks overlain by a clastic metasedimentary succession of psammite, sandstone and granule to pebble conglomerate (Unit 4), black slate, graphitic schist and phyllite (Unit 5) and variably bedded psammite, semipelite, phyllite and sandstone (Unit 6). The Bay du Nord Group yields evidence of at least two periods of deformation, the first of which produced locally recumbent structures and was accompanied by an upper greenschist to amphibolite grade metamorphic event. The later deformation produced upright folds and a widely developed second regional foliation. The La Poile Group (Unit 7) is exposed in a narrow roof pendant zone in the Burgeo batholith. It consists of thermally metamorphosed massive, cross-laminated, and planar bedded gray sandstone.

The Burgeo batholith underlies approximately 60% of the area and includes a northern phase of variably porphyritic, medium to coarse grained biotite (± rare hornblende) granite

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Contribution to the Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Newfoundland Department of Mines and Energy.

(Unit 9), a southern and locally later phase of fine and predominantly medium grained equigranular biotite(-poor) granite (Unit 10) with included metasediment and migmatite (Unit 8), and a late phase of fine grained, pink equigranular biotite ± muscovite granite and aplite (Unit 11). The porphyritic phase is variably deformed and metamorphosed and locally displays a strong cataclastic fabric, particularly along the trace of the Dragon Bay Fault (Blackwood, 1983). Equigranular biotite granite locally intrudes the porphyritic phase and is in many places relatively less deformed.

Large zones of migmatite and metasediment (Unit 8), common within the equigranular phase (Unit 10), display a variety of textures and locally contain sillimanite. In the southwest corner of the area, migmatites, intruded by pegmatite and polydeformed granitoid, are cut by post-tectonic pink equigranular granite. Similar late granites occur in the southeast (Unit 11), where they form the latest phase in the batholith. The North Bay Granite (Unit 12) underlies the northeast corner of the area, is intrusive into the Bay du Nord Group, and consists of very coarsely porphyritic biotite granite.

Units 13, 14 and 15 are the youngest granites in the area, and are variably deformed, muscovite-bearing, equigranular and mineralized. The granites, themselves poorly exposed, occur in a largely drift- and bog-covered area and may be much more areally extensive in the subsurface.

Mineralization

The gabbros of Unit 1 host small showings of pyrite and chalcopyrite on the ridges north of Pigs Head. The overlying Bay du Nord Group contains several sulfide showings, the largest of which occurs in felsic volcanics of Unit 2, three kilometres west-northwest of Grey Lake. There, rhyolite flows contain disseminated pyrite, chalcopyrite and arsenopyrite. Small pyritiferous zones occur in the volcanics along strike in White Bear River and northeast of Top Pond. The Bay du Nord Group sediments contain numerous pyritiferous zones. Pyrite-arsenopyrite-quartz veins are also common in Unit 6; these have been reported to be scheelite-bearing (Smyth, 1979). Along the margins of Unit 15, the Bay du Nord Group is cut by molybdenite-pyrite-arsenopyrite- bearing quartz veins.

The greatest potential for economic mineralization lies in the granitoid rocks of Units 13, 14 and 15. They were intruded at various stages of the regional deformation; Unit 15 is in part post-tectonic. These units contain muscovite-tourmaline-lepidolite-garnet-bearing phases, and are anomalously radioactive, with backgrounds of 200 to 400 c.p.s. (total counts). One of these granites (Unit 14) may be the source of the uranium mineralization described below. All should be treated as having high potential for Sn-W-U mineralization.

Scheelite occurs as fracture-coating in aplitic and leucogranitic dikes that outcrop approximately 3.5 km northwest of Grey Lake. The dikes may be related to either the Burgeo batholith or granitoids of Unit 15.

Three new uranium showings were discovered during the mapping. Theshowings are all hosted by rocks of the Bay du Nord Group; two are areally associated with muscovite- garnet-bearing leucogranite dikes related to either or both Units 13 and 14. One showing consists of several large tabular radioactive boulders (sub-outcrop) of Unit 3 tuff. These boulders yield readings in excess of 10,000 c.p.s. (total counts). Two other showings, several tens of metres distant from each other, occur in volcanic and sedimentary rocks respectively; these showings lie 3 km along strike to the east of the radioactive sub-outcrop. The sediment-hosted mineralization occurs in quartz-veined

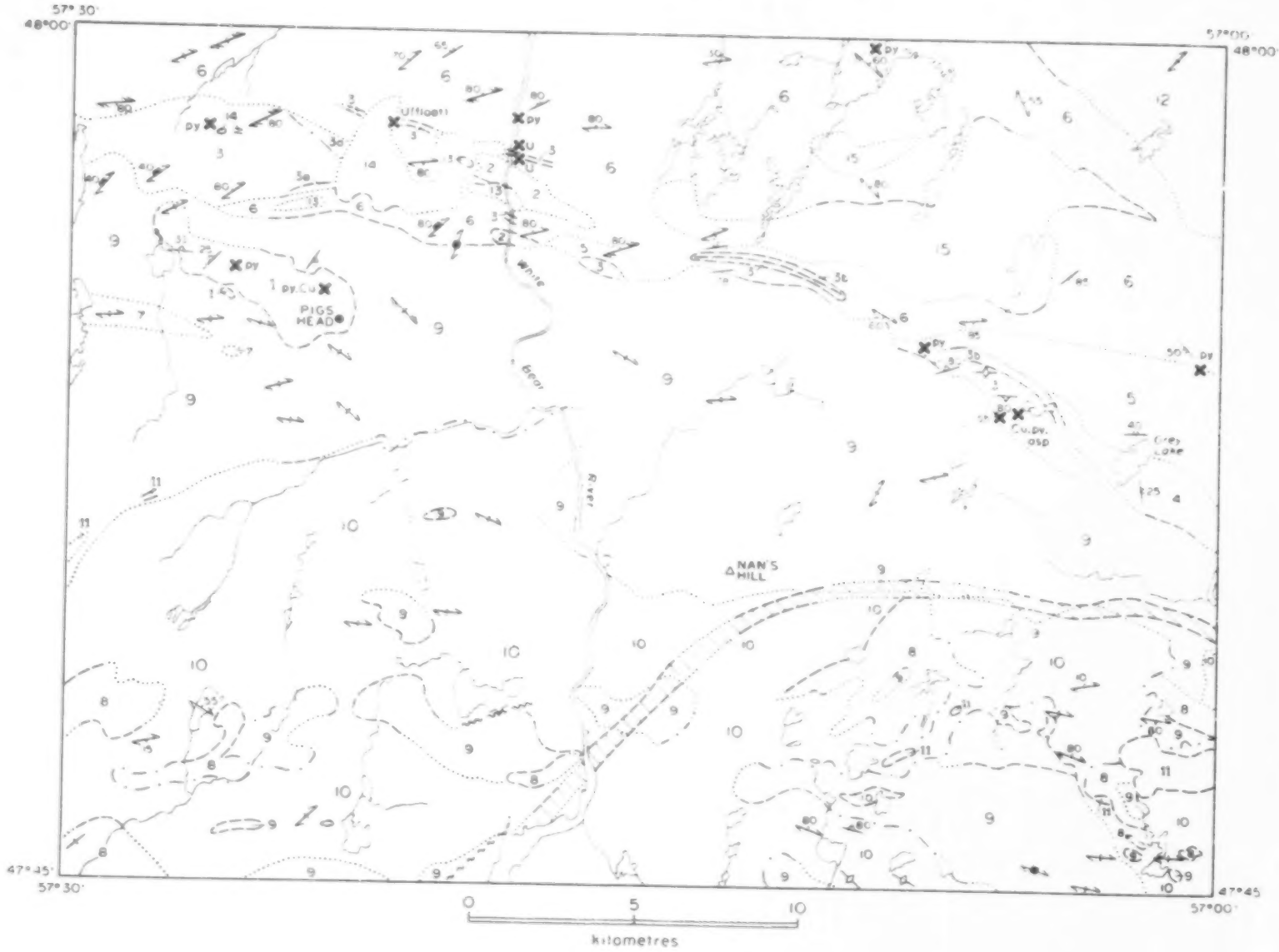

Figure 1: *The geology of the White Bear River map area (11P/14).*

LEGEND

DEVONIAN(?) or earlier

15 Fine to medium grained, equigranular muscovite-biotite granite; lepidolite-tourmaline-garnet-bearing aplite rare porphyritic granite.

14 Pink felsite and fine grained granite; muscovite-tourmaline leucogranite.

13 Fine to medium grained, equigranular to porphyritic granite.

North Bay Granite

12 Coarse grained feldspar porphyritic biotite granite.

Burgeo Batholith (Units 9-11)

11 Fine to medium grained, pink equigranular biotite granite.

10 Medium grained, mainly equigranular biotite granite.

9 Variably (feldspar) porphyritic, medium to coarse grained, biotite (± rare hornblende) granite (S.L.).

ORDOVICIAN(?)

8 Psammite. semipelite and migmatite.

La Poile Group

7 Gray sandstone.

Bay du Nord Group (Units 2 to 6)

6 Thickly to thinly bedded, gray psammite, semipelite, phyllite. sandstone and shale.

5 Black slate. graphitic schist, phyllite and minor semipelite.

4 Medium to coarse grained sandstone granule to pebble conglomerate psammite.

3 Rhyolite, flows, massive and banded felsic tuff, **3a**, tuffaceous sediments; **3b**, siliceous bedded tuff.

2 Mafic tuff and tuffaceous sediment, amphibolite.

ORDOVICIAN or earlier

I Massive and layered metagabbro; metadiabase; minor pyrixenite and dunite.

porphyroblastic semipelite (Unit 6) containing tuffaceous interbeds; total counts of 6,000 c.p.s. were recorded at this showing. The third showing of about 2000 c.p.s. occurs in a felsic tuff layer within the metasediments.

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GEOLOGY OF THE WOLF MOUNTAIN (12A/2E) AND DOLLAND BROOK (11P/15E) MAP AREAS, SOUTH-CENTRAL NEWFOUNDLAND

by

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Summary

The North Bay Granite is a late Acadian (Silurian-Devonian) composite intrusion which has syn- to post-tectonically intruded the metasediments and metavolcanics of the Ordovician Baie d'Espoir Group and the Spruce Brook Formation (subunits 1a - 1e), and the Silurian? coarse clastic sediments of Units 2 and 4.

Introduction

Field mapping was carried out on the North Bay Granite in the Dolland Brook (11P/15E) and Wolf Mountain map areas (12A/2E) in south-central Newfoundland (Figure 1). Adjacent metamorphic rocks within the map areas were also examined. A geochemical grid sampling program was carried out during field mapping. Thus, with the mapping and geochemical sampling carried out by Colman-Sadd (1976, 1983, *this volume*), Colman-Sadd *et al.* (1981, *this volume*), Blackwood (1983, *this volume*), Dickson (1982), and Dickson and Tomlin (1983), detailed coverage of the North Bay Granite between Granite Lake and St. Alban's is complete.

Description of Units

Unit 1 has been divided into five subunits on the basis of distinctive lithologies. Subunit 1a is generally a strongly metamorphosed biotite psammitic schist with psammite interbeds. Where the unit is not highly metamorphosed, e.g. in the southwestern part of the unit, it consists of interbedded sandstone and slate. Subunit 1b is a thickly bedded, quartz-crystal tuff which is strongly cleaved. Subunit 1c is a thinly bedded, graphitic-silicified slate and siltstone unit which is highly deformed with tight, southwest plunging isoclinal folds. Subunit 1c structurally overlies subunit 1b and is interbedded with the lower parts of subunit 1d. Subunit 1d is a very thickly bedded brown sandstone generally devoid of sedimentary structures. Subunit 1e is a low grade green to black slate with minor interbedded sandstone. The similarity in color, texture and lithology between subunit 1e and parts of Unit 3 suggests that the two may be part of the same sequence. Close to the contact with the North Bay Granite, Unit 1 commonly contains porphyroblasts of cordierite and andalusite.

Unit 2 is mainly a very thickly bedded, clast-supported conglomerate comprising well sorted and well rounded cobbles and pebbles of white orthoquartzite in a coarse sandy matrix. Graded bedding of the conglomerate and sandstone interbeds only rarely occur. The orthoquartzite clasts are similar to well bedded, quartz-rich sandstones which occur in the Spruce Brook Formation (subunit 1a). Unit 2 is interpreted as unconformably overlying subunit 1a.

Contribution to Canada-Newfoundland co-operative minerals program 1982-84. Project financed by the Geological Survey of Canada and Newfoundland Department of Mines and Energy.

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LEGEND

DEVONIAN - CARBONIFEROUS?

7 Massive, fine grained, quartz-feldspar porphyry dikes

SILURIAN - DEVONIAN?

6 Strongly mylonitized, medium grained, equigranular to porphyroclastic, biotite granite - part of the Burgeo batholith?

5 North Bay Granite
- **5a:** Massive to weakly foliated, medium grained. K-feldspar porphyritic, biotite granite.
- **5b:** Massive to weakly foliated, medium grained, K-feldspar porphyritic, biotite-muscovite granite.
- **5c:** Massive to weakly foliated, medium grained, K-feldspar porphyritic, biotite+muscovite granite.
- **5d:** Massive to weakly foliated. medium grained, equigranular to slightly porphyritic, biotite+muscovite granite.
- **5e:** Massive, coarse grained, equigranular, biotite±muscovite granite.
- **5f:** Foliated, medium grained, equigranular, biotite+muscovite granite with abundant screens of migmatite.
- **5g:** Strongly foliated, medium grained to pegmatitic biotite-muscovite and muscovite-garnet granite.
- **5h:** Foliated, medium to coarse grained, equigranular to porphyritic, biotite granodiorite.
- **5i:** Foliated, medium grained, equigranular, biotite tonalite.
- **5j:** Granite? - no exposure

4 Migmatite
- **4a:** Migmatite, psammite cut by numerous granite dikes metasediments probably high grade equivalent of subunit 1a.
- **4b:** Migmatite and psammite cut by numerous foliated granitoid dikes; metasediments probably high grade equivalents of the Ordovician Bay du Nord Group.

SILURIAN?

3 Thinly to very thickly bedded sedimentary breccias with thinly interbedded, cleaved coarse sandstone. siltstone, pebble conglomerate, and, locally, slate.

2 Mainly very coarse orthoquartzite-cobble conglomerate with minor interbedded sandstone locally thickly bedded breccia with shale clasts.

ORDOVICIAN

1 Spruce Brook Formation (1a) and Baie d'Espoir Group (1b-1e).
- **1a:** Upper greenschist to amphibolite facies psammite and semipelite.
- **1b:** Thickly bedded, schistose quartz-crystal tuff.
- **1c:** Highly folded. black graphitic pelite and semipelite.
- **1d:** Thickly bedded semipelite.
- **1e:** Gray and green pelite and slate.

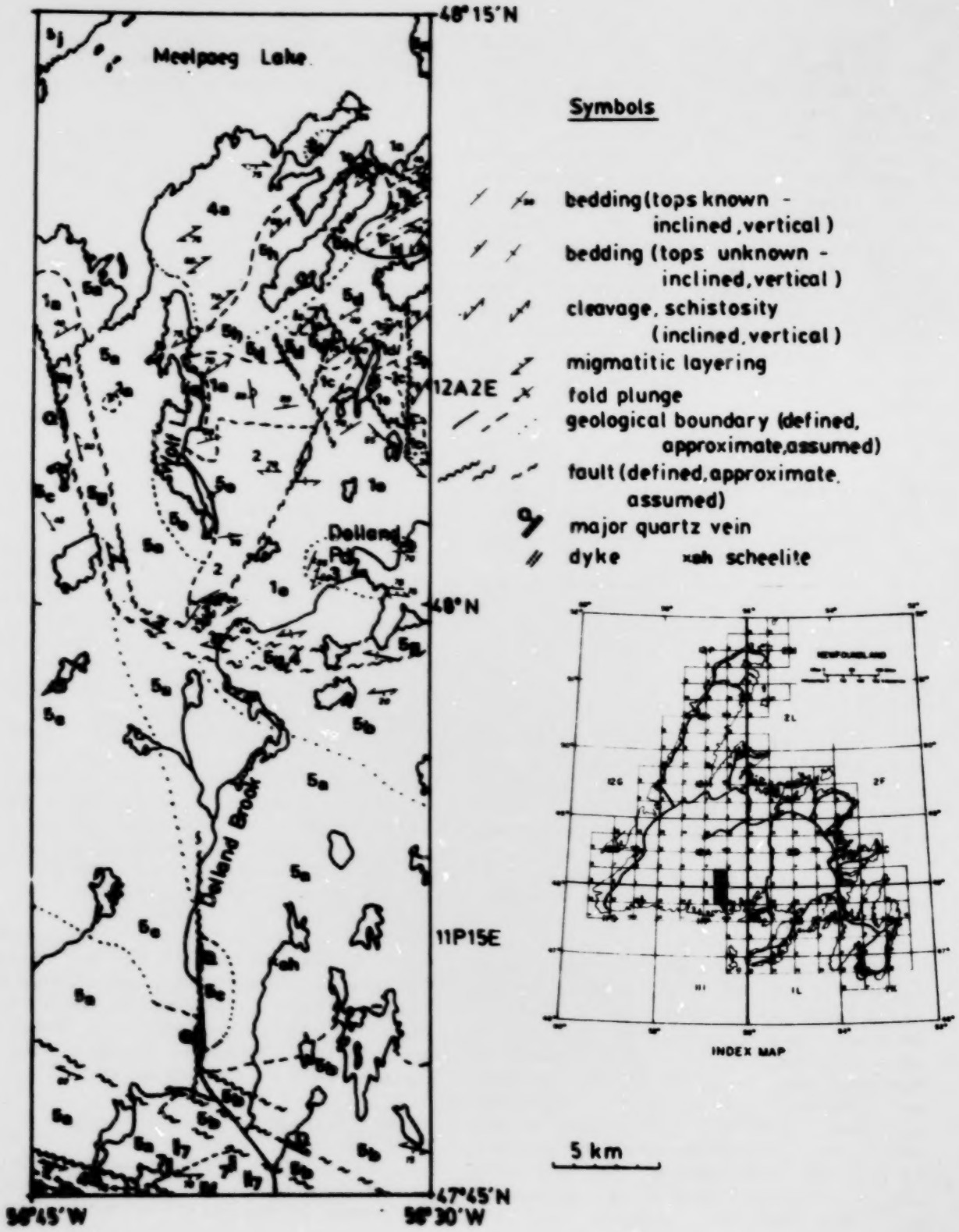

Figure 1: *Geology of the Wolf Mountain (12E/2E) and Dolland Brook (11P/15E) map areas.*

Unit 3 is mainly exposed around Dolland Pond, with rare scattered occurrences on Dolland Brook and 2 km west of Dolland Pond. The most prominent lithology is a matrix supported pebble conglomerate which is interbedded with coarse sand and silt. The conglomerate units range up to 3 m in thickness but are generally only 30 cm to 1 m thick. The clasts in the conglomerate vary from angular shale fragments to well rounded pebbles of sandstone and chert(?). The matrix is commonly silt or sand. Graded bedding and crossbedding indicate an upright synclinal structure with an easterly plunge in the Dolland Pond area.

Unit 4 mainly consists of migmatites and biotite psammite which in the Meelpaeg Lake area are probably equivalent to Unit 1 and were deformed and metamorphosed during the Silurian-Devonian Acadian orogeny. In the southern part of the Dolland Brook area, the migmatites probably form part of the Ordovician Bay du Nord Group. South of Dolland Pond, the migmatites occur as large xenoliths in the highly deformed granites (subunit 5g).

The North Bay Granite (Unit 5) has been divided into ten subunits. The main features of each subunit are listed in the legend for Figure 1. However, these may be simplified into a biotite-bearing unit which underlies most of the area and a biotite + muscovite-bearing unit. Only in subunits 5b, 5e and 5g is muscovite a prominent mineral.

The most prominent structural feature of the North Bay Granite in the map area is the arcuate belt of strongly deformed muscovite-bearing granitoids which extends from the western part of Meelpaeg Lake to south of Dolland Pond and continues eastward into the adjacent map area (11P/16). In a few areas, brecciation indicates that the subunit is probably fault bounded. The generally gently to moderately dipping cleavage in the rocks possibly indicates that the subunit is a thrust slice and that the granitoids and/or metasediments to the northeast were thrust over subunit 5g.

Subunit 5h is also strongly deformed with a prominent fabric defined by biotite and flattened feldspars and quartz. The remaining units are either massive or show only a weak fabric.

In the southern part of the map area, southwest of Dolland Brook, subunit 5a commonly contains xenoliths and screens of migmatite and foliated granite identical to that from Unit 4 to the south. This indicates that the main period of deformation and metamorphism predated the emplacement of the North Bay Granite.

Unit 6 is located in the southwest corner of the map area and consists of a mylonitic to ultramylonitic equigranular granite. This mylonitic granite is part of a narrow mylonite zone which extends to the northwest (see Blackwood, this volume) and to the southeast, where the mylonite forms part of the Dragon Bay fault zone (Blackwood, 1983). Unit 6 probably forms part of the eastern margin of the Burgeo batholith (O'Brien 1983; O'Brien and Tomlin, *this volume*).

Unit 7 is a very fine grained to rhyolitic quartz-feldspar porphyry which forms dikes up to 10 m in thickness with some probably exceeding 500 m in length. These dikes have intruded the weakly foliated granitoids of subunit 5a and 5f but the dikes are entirely massive. Similar dikes occur to the west in map areas 11P/15W and 11P/14 (Blackwood, *this volume*, and O'Brien and Tomlin, *this volume*, respectively). These dikes may be offshoots from the post-tectonic Francois Granite located to the south of the map areas.

Mineralization

Only minor sulfide mineralization was discovered in the map area. Pyrite is common in the pelite of subunit 1c. A

trace of molybdenite was discovered near the contact between the granite of subunit 5d and subunit 1a, 5 km northeast of Wolf Lake. Minor scheelite mineralization was discovered in pyritic altered granite east of Dolland Brook (McConnell, *this volume)* and corresponds to a lake sediment tungsten anomaly outlined by Davenport and Butler (1982).

Large quartz veins associated with faults were found in the Dolland Brook area, east of Dolland Brook and southwest of Meelpaeg Lake. The veins are over 200 m long and 15 m wide. The veins are composite and consist of several generations of quartz with inclusions of highly altered granite. No mineralization was found in the veins, but they will be assayed for gold.

Further work

Samples of granite and vein quartz were taken from 157 sites during the survey. These samples will be analyzed for major elements, and selected trace elements including Sn, U, W, Mo, Pb, Zn, Cu, Nb and Zr.

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GEOCHEMICAL SURVEYS OVER THREE TUNGSTEN ANOMALIES IN THE NORTH BAY BATHOLITH, SOUTHERN NEWFOUNDLAND

by

John McConnell
Geochemistry Section

INTRODUCTION

The recent discovery of tungsten and molybdenum mineralization in the Granite Lake area of the North Bay Batholith and tin mineralization in the Ackley Granite has spurred exploration interest. In view of this, the Geochemistry Section began a two-year project in 1982 of assessing the mineral potential of some granitoid terrains and evaluating the effectiveness of various exploration methods. Areas were selected on the basis of being mineralized and/or having lake sediment anomalies characteristic of mineralized granites. During the summer of 1982, soil, stream and rock sampling was done in the areas of Granite Lake (W-Mo mineralization), the southern portion of the Ackley Granite (Sn-Mo mineralization), and Francois (Pb-F-U-Mo lake sediment anomaly) (McConnell, 1983).

Both the stream sediment and the soil surveys were found to be very effective in reflecting tungsten mineralization in the Granite Lake area.

During the summer of 1983, the granite project was continued and geochemical surveys were conducted over three areas of the North Bay Batholith (Fig. 1). The areas were chosen because of their high values of W in lake sediment as indicated by recent data of Davenport and Butler (1982). No previous exploration for W has been reported from these areas, although portions of all three were staked by a mining company following the release of the Davenport - Butler data.

BOTTOM BROOK ANOMALY

Bedrock and Glacial Geology The most recent and detailed bedrock mapping in the area (N.T.S. 11P/16) is that of Dickson and Tomlin (1983). Outcrop in the 120 km^2 area is scarce. Where present, it consists of massive to foliated, biotite ± muscovite, medium to coarse grained granite considered of Silurian age. In some instances, the granite grades into pegmatite. Examples of quartz veins both in outcrop and in float were observed, some slightly mineralized with pyrite.

Topographic relief is low and the area is covered by a moderate thickness of sandy till. Several ice-contact drift deposits and south-southeast trending eskers were noted. Direction of ice movement is considered to have been generally from north to south. Typically, the ground is mantled by large angular boulders of granite similar in composition to that observed in outcrop. However, the compositions of the small lithic fragments contained within the soil profile, as noted during soil sampling, were predominantly meta-

Contribution to the Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Newfoundland Department of Mines and Energy and the Geological Survey of Canada.

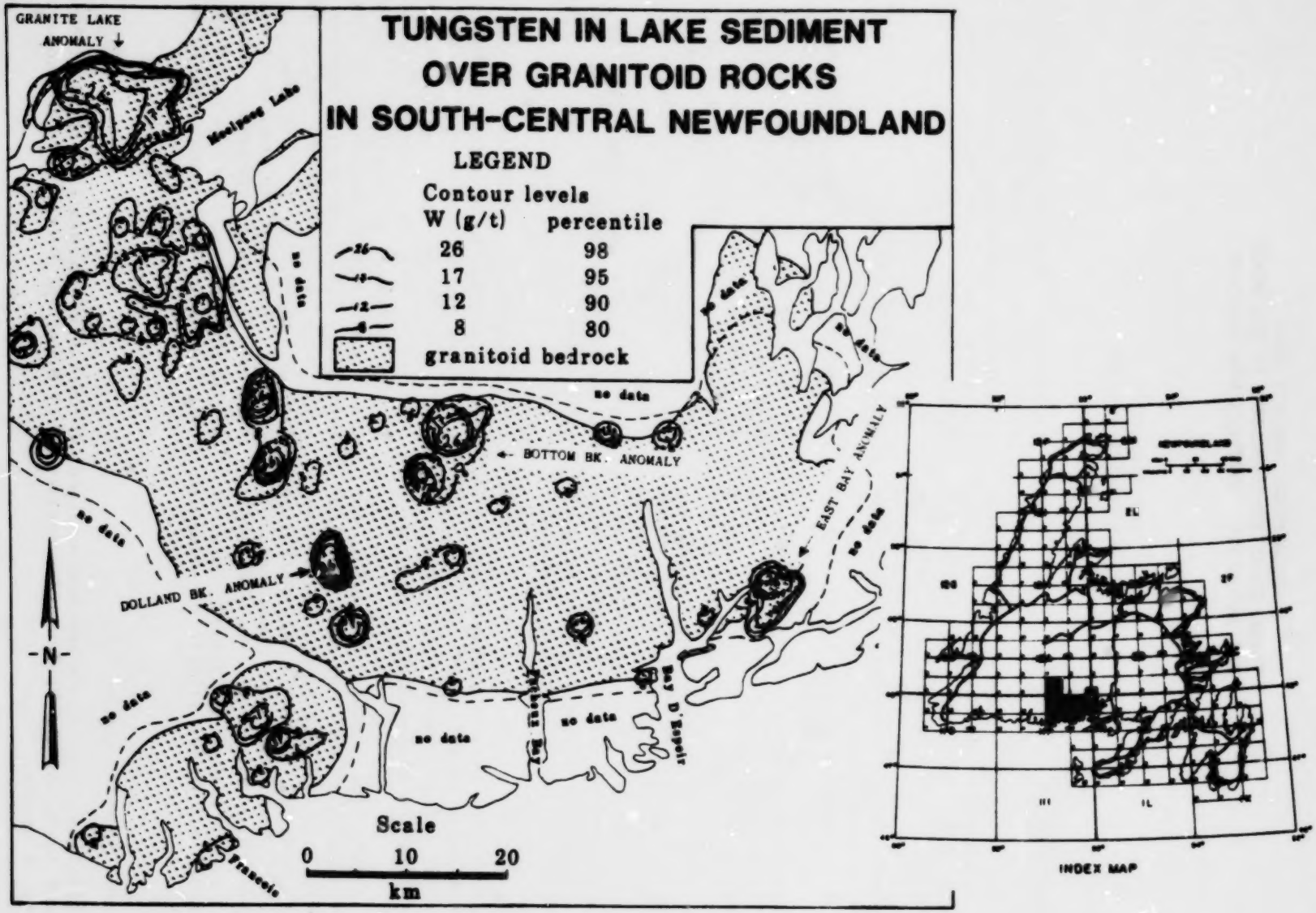

Figure 1: Distribution of W in lake sediment and location of follow-up areas. (Geochemistry after Davenport and Butler, 1982).

clastic and meta-igneous, suggesting a considerable distance (5-10 km) of transport. This observation suggests that a significant component of the soil material sampled may also have been derived from a source several kilometres to the north.

Geochemical Sampling and Analyses Tungsten is the only element known to have anomalously high concentrations in lake sediments of the Bottom Brook area. The anomaly has two facies - a northern three sample cluster of approximately 40 g/t W and a looser four sample group ranging from 14 to 31 g/t W located about 5 km to the southwest. Two types of sampling - soil and stream sediment - were employed in an effort to better define the W anomaly. B-horizon soils were sampled at 400 m intervals along E-W lines spaced 1 km apart. Some closer spaced lines were sampled over the centre of the northern portion of the lake sediment anomaly. Well defined B-horizon material, mostly sand-silt in texture, was usually obtained. In total, 120 km of line were sampled and 332 samples collected. 246 conventional stream sediments were also collected from the 120 km^2 of anomalous terrain. Active sediment was easily obtained in most instances. In addition, 25 samples of granitic bedrock, locally derived float and quartz veins were obtained.

Samples will be analyzed for W and Sn plus the suite - Cu, Pb, Zn, Co, Ni, Ag, Mn, Fe, Mo, F and Loss-on-ignition - and the data released on Open File as soon as possible.

EAST BAY ANOMALY

Bedrock and Glacial Geology The field area encompasses 30 km^2. Relief is rugged, outcrop abundant, and till cover thin to nonexistent. The area straddles portions of N.T.S. sheets 11P/16 and 1M/13. The most recent geological mapping in 11P/16 is by Dickson and Tomlin (1983) and in 1M/13 by Colman-Sadd (1976). The central part of the anomaly is underlain by leucocratic North Bay Granite (Silurian) which irregularly intrudes psammites of the Riches Island Formation (Ordovician) toward the perimeter of the area. Immediately to the east of the sampling area, disseminated molybdenite occurs in pegmatites, regarded as emanations from the North Bay Granite, which intrude psammites of the Riches Island Formation (Colman-Sadd, 1976).

Geochemical Sampling and Analyses The high W contents in lake sediments (up to 30 g/t) are from lakes overlying the granite. Elevated values of Pb, Mo, Cu and Ag also occur in the lake sediments. Stream sediment samples (156) were collected across the area. Streams and sediments are abundant, although drainage systems are poorly developed. The samples will be analyzed for the same suite of elements as described above for Bottom Brook.

DOLLAND BROOK ANOMALY

Bedrock and Glacial Geology The field area (in southeastern N.T.S. sheet 11P/16) encompasses 30 km^2 and is everywhere underlain by the North Bay Granite. In general, it is massive, unfoliated, medium grained, porphyritic, biotite ± muscovite granite. Previous to this summer, no mineralization was known in the area. The field party found a small occurrence of pyrite in veins and disseminations in an altered quartz-feldspar-muscovite rock. Rock samples from this occurrence have trace amounts of a disseminated mineral which fluoresces bluish white under ultraviolet light and which tentatively has been identified as scheelite (for location map, see Dickson and Delaney, this volume).

This area was geologically mapped in 1983 at 1:50,000 scale by Dickson and Delaney. No mapping of the Quaternary geology has been done, but features noted in the field indicate a southerly movement of ice. A thin to moderately

thick blanket of sandy drift is present over virtually the entire area. Relief is low except across the deep valley formed by Dolland Brook.

Geochemical Sampling and Analyses

The lake sediment anomaly is defined by three lakes with W values ranging from 11 to 35 g/t. No other anomalous concentration of elements was noted. Samples (75) of B-horizon soil were taken at 400 m intervals along lines spaced 1 km apart. Stream sediments (128) were collected from across the area. Several rock samples of typical bedrock and mineralization were also taken. All samples will be analyzed for the element suite described above.

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GRAVITY SURVEYS

by

H.C. Miller

Gravity data were collected in association with two of the projects described elsewhere in this volume. The first gravity survey investigated the geophysical signature of the Ocean Pond anomaly identified by Miller and Weir (1982) in the northeastern part of the Gander Zone (Figure 1). This survey was conducted in conjunction with a stream geochemistry sampling program by J. Butler *(this volume)*. The second set of gravity data were collected across the Ackley batholith and across a smaller pluton in the vicinity of the Ackley (Figure 2) in association with a geological project headed by J. Tuach *(this volume)*.

The gravity data for both surveys were collected using a LaCoste-Romberg land gravity meter, serial number G444. Elevations were obtained from barometric altimeters using survey methods designed to increase the accuracy of the results (Miller and Deutsch, 1976). Positions were scaled from 1:50,000 topographic maps. The gravity bases at Gander and Terrenceville are tied to the National Gravity Network, which is the worldwide part of IGSN71. Bouguer anomalies at each station were calculated using the appropriate base value, the 1968 International Gravity Formula, and a crustal density of 2.67 g. cm^{-3}. These are absolute anomalies similar to those on the Canadian data base which can be directly compared with other Bouguer anomalies calculated using this reduction system. In order to compare these anomalies with those on the older anomaly maps published for Newfoundland by the Dominion Observatory (Weaver, 1967, 1968), approximately 6.3 mGal must be subtracted from the older Weaver data. Alternatively, the revised Weaver data on the new international datum may be obtained from the Earth Physics Branch, Department of Energy, Mines and Resources, Ottawa.

Gander Survey

This survey consisted of a total of 37 gravity stations arranged along three traverses (Figure 1). The southern two traverses were designed to obtain more detailed geophysical information on the nature of the Ocean Pond anomaly, a belt of higher gravity and magnetic anomalies recognized by Miller and Weir (1982) to be coincident with a belt of geochemical anomalies similar to those found in the Gander River Ultramafic Belt to the west.

The data (Figure 1) demonstrate that the anomaly near Ocean Pond consists of two regions, the western part called the Ocean Pond anomaly and an eastern part termed the Indian Bay Big Pond anomaly. The detailed gravity data of the present survey suggest that the Indian Bay Big Pond anomaly belt contains up to 1.5 km of anomalous material at fairly shallow depth. The largest anomaly found on the present survey was in the Indian Bay Big Pond area, suggesting an increase in peak anomaly northward. The Indian Bay Big Pond anomaly is consistent with reports of volcanics in the area (Blackwood, 1978). Further interpretation involving modelling methods will be employed to ascertain the subsurface configuration of the anomalous material.

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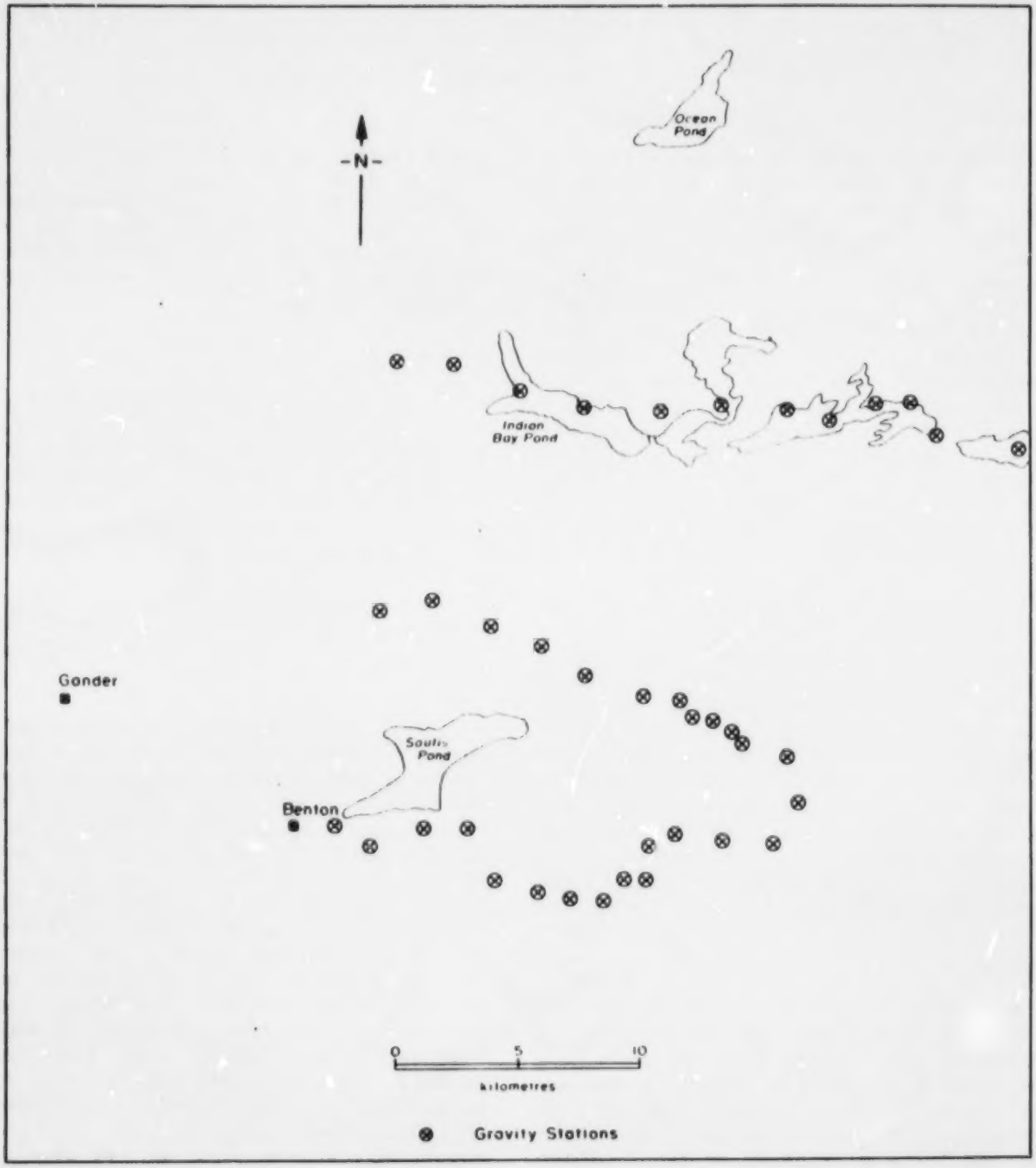

Figure 1: *Gander gravity survey.*

Ackley Survey

This survey consisted of 52 stations along three traverses (Figure 2). The principal traverse was a 65 km line across the Ackley batholith using 5 km spacings. The objective of this line was to examine the correlation of the gravity and aeromagnetic data with the geological mapping of the pluton.

The second portion of this survey consisted of detailed 1 km spacing survey over a small pluton in the area in an effort to determine its subsurface configuration.

Only the data reduction has been completed to date (September 15). Further interpretation awaits the measurement of densities and magnetic susceptibilities of samples from the area.

Data Availability

The Gander data collected this year are part of a larger data set for the Gander Zone north of the Trans Canada Highway. The data for the whole area are available upon request in map form at the cost of computer processing, by contacting the author.

Acknowledgements

The author wishes to thank the personnel from the two mapping projects who assisted in the data collection, namely John Tuach, Jim Butler and Margot Davis. In addition, Jim Everard and Samuel Peavy of Memorial University collected and processed the Ackley gravity data. John Tuach and Jim Butler are especially thanked for providing the helicopter time from their tightly pressed schedules.

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Figure 2: *Ackley gravity survey.*

METALLOGENIC STUDIES OF GRANITE-ASSOCIATED MINERALIZATION IN THE ACKLEY GRANITE AND THE CROSS HILLS PLUTONIC COMPLEX, FORTUNE BAY AREA, NEWFOUNDLAND

by

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Mineral Deposits Section

INTRODUCTION

This project is designed to develop metallogenic and exploration models for granite-associated mineralization in the Ackley Granite and Cross Hills Plutonic Complex, southeast Newfoundland. It commenced in 1983. Field data collected during the 1983 field season will form the basis for a Ph.D. study by the author at Memorial University.

PREVIOUS WORK

Regional mapping has been performed by Bradley (1962), Williams (1971), O'Brien and Nunn (1980) O'Brien et al. (1980a,b) and Dickson (1983).

Aplite-pegmatite molybdenum deposits have long been known in the Rencontre area and occur at the contact of a fine to medium grained porphyritic phase of the Ackley Granite with volcanic rocks of the Belle Bay Formation (Figure 1). The geology, geochemistry and exploration history of these deposits have been described in detail by Whalen (1976, 1980).

Cassiterite-bearing quartz-topaz greisen veins have recently been identified by Esso Minerals Limited, and by the Newfoundland Department of Mines and Energy (Dickson, 1982; Dickson and Howse, 1982) in the Anesty Hill - Sage Pond area (Figure 1). These veins occur within a fine to medium grained, porphyritic marginal phase of the Ackley Granite and increase in concentration and size toward the granite contact (Dickson, 1983).

A peralkaline phase of the Cross Hills plutonic complex with minor anomalous radioactive zones and anomalous Nb, Zr and Th has been identified by Saarberg Interplan (Hopfengaertner, 1982).

WORK PERFORMED - 1983 FIELD SEASON

(1) Quartz-topaz veins were mapped in detail along the Ackley Granite contact between Rabbit Pond and Gisborne Lake (Figure 2).

(2) Rock samples were collected from the quartz-topaz veins in the Sage Pond area (Figure 2) and from the molybdenite prospects at Motu, Ackley City, Crow Cliff - Dunphy Brook and Wyllie Hill for geochemical analysis and for fluid inclusion studies (Figure 1). All known molybdenum occurrences in the Ackley Granite were examined and sampled, and samples were collected from the Strouds Hill fluorite prospect at the south end of Long Harbour (Figure 1).

Contribution to Canada-Newfoundland co-operative mineral program 1982-84. Project financed by the Geological Survey of Canada.

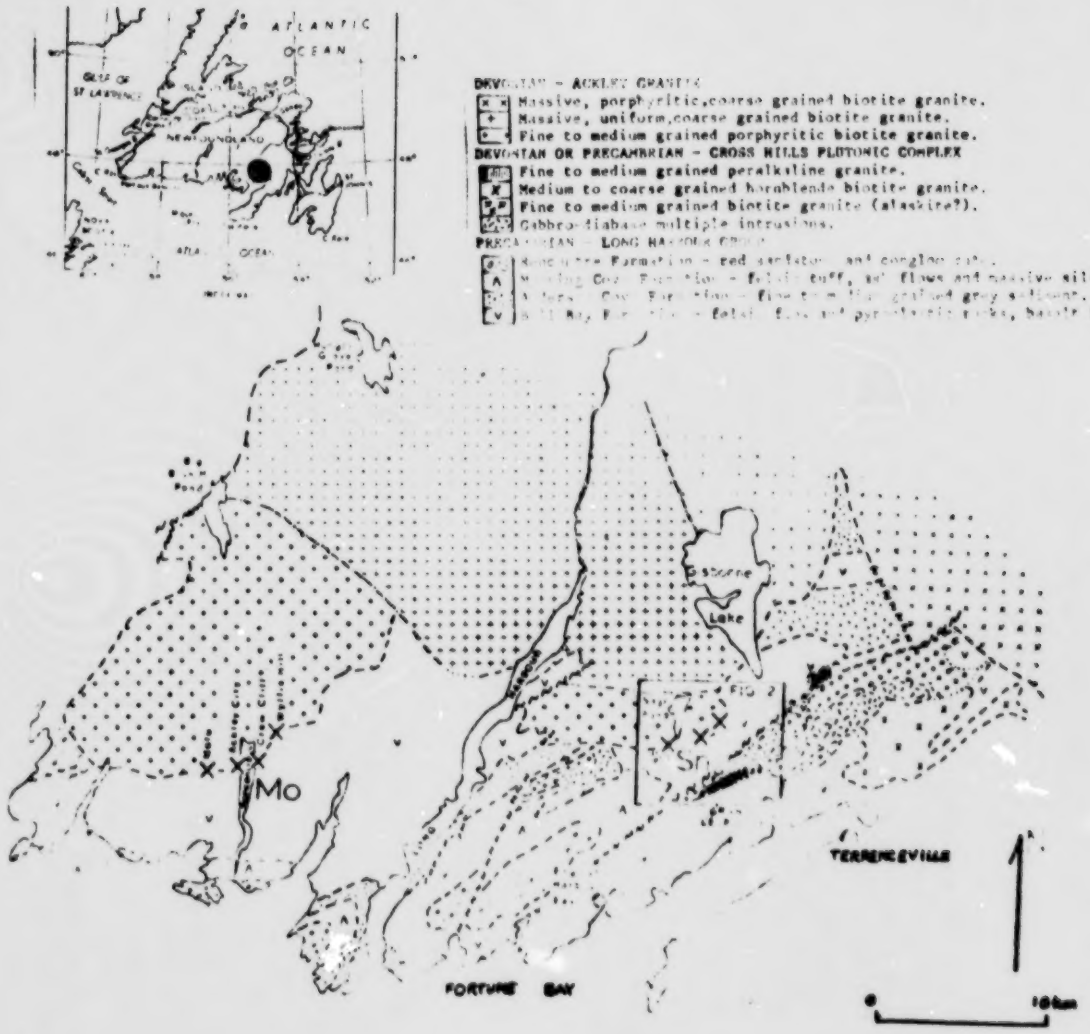
ATLANTIC OCEAN
DEVONIAN - ACKLEY GRANITE
Massive, porphyritic, coarse grained biotite granite.
Massive, uniform, coarse grained biotite granite.
Fine to medium grained porphyritic biotite granite.
DEVONIAN OR PRECAMBRIAN - CROSS HILLS PLUTONIC COMPLEX
Fine to medium grained peralkaline granite.
Medium to coarse grained hornblende biotite granite.
Fine to medium grained biotite granite (alaskite?).
Gabbro-diabase multiple intrusions.
Mo
Lake
TERRENCEVILLE
FORTUNE BAY
10km

Figure 1: *General geology north of Fortune Bay, Newfoundland.*

(3) The Cross Hills plutonic complex west of Grand Le Pierre and Precambrian volcanic rocks intervening between the Cross Hills plutonic complex and the Ackley Granite were mapped at a scale of 1:15,000 (Figure 2). Several traverses were made over the Cross Hills plutonic complex to the east of Grand Le Pierre.

GENERAL GEOLOGY (Figure 1)

Plutonic rocks in the area of interest to the north of Fortune Bay intrude Precambrian subaerial metavolcanic and metasedimentary rocks of the Long Harbour Group (Williams, 1971; O'Brien and Nunn, 1980) in the Avalon Terrane of the Newfoundland Appalachians (Williams and Hatcher, 1983).

The Long Harbour Group has been subdivided into four separate conformable formations (Bradley, 1962; Williams, 1971; O'Brien and Nunn, 1980). The stratigraphically lowest Belle Bay Formation is dominated by felsic ash flows and epiclastic sediment with minor basalt flow, and is overlain by fine to medium grained sediments of volcanic origin belonging to the Andersons Cove Formation. The overlying Mooring Cove Formation consists of interbedded silicic flows, felsite (commonly with peralkaline affinity, O'Brien, personal communication, 1983) and mafic flows. A red to purple fining upward conglomerate to sandstone sequence named the Rencontre Formation overlies the Mooring Cove Formation.

The Cross Hills plutonic complex intrudes the Belle Bay and Anderson Cove Formations and consists of a complex mixture of diabase, gabbro, granodiorite, alaskite and peralkaline granite along with abundant xenoliths and roof pendants of silicic volcanic and mafic intrusive-extrusive rocks. The Cross Hills plutonic complex has not been dated; however, observation that gabbroic phases are cut by the Ackley Granite, and that there is a general lack of deformation and metamorphic effects has led to a consensus that these plutonic rocks are Devonian in age (Bradley, 1962; O'Brien and Nunn, 1980). The peralkaline granite phase of the Cross Hills complex is geochemically comparable to the peralkaline silicic volcanic rocks of the Mooring Cove Formation (O'Brien, personal communication, 1983), and a coterminous age of Devonian or Precambrian may be inferred for both. The generally accepted stratigraphic ages for both units are depicted in Figures 1 and 2, pending resolution of this problem.

The Devonian Ackley Granite occupies an area 3000 km^2 and has been divided into seven major units based on texture, mineralogy and geochemistry (Dickson, 1983) with the three most differentiated southern units having a silica content of greater than 75%. Fine grained, extremely differentiated marginal granite phases occur along and near the southern contact of the Ackley Granite, and exhibit strong trace element variation trends (Whalen, 1976, 1980; Dickson, 1983). The marginal phases hosting mineralization are fine grained to porphyritic biotite 'alaskite' granite and commonly exhibit pegmatitic quartz-feldspar pods and miarolitic texture. In the Fortune Bay area, the Ackley Granite cuts the Belle Bay and Anderson Cove Formations, and gabbroic rocks of the Cross Hills complex, and has been dated at 355 Ma (Bell et al., 1977; Newfoundland Department of Mines and Energy, 1980).

GEOLOGY - SAGE POND - GRAND LE PIERRE AREA (Figure 2)

Volcanic Complex (Units 1 and 2)

The English Harbour volcanics (Bradley, 1962) south of the Cross Hills pluton consist of massive to slightly fractured, well lithified light to dark rhyolite flows, welded ash flows, breccias and tuff (Unit 1a).

Figure 2: *Geology, Grand Le Pierre - Sage Pond area, Fortune Bay, Newfoundland.*

LEGEND (Figure 2)

PLUTONIC ROCKS

DEVONIAN - ACKLEY GRANITE

Quartz-topaz and/or quartz-muscovite greisen. Less than 10 by 2 m except where lettered.

4a Fine to medium grained orange quartz-feldspar porphyritic granite.

4 Medium to coarse grained equigranular biotite granite.

DEVONIAN - POSSIBLY PRECAMBRIAN - CROSS HILLS PLUTONIC COMPLEX

3d Aplite(?) very fine grained, red-brown.

3c Fine to medium grained, miarolitic red-brown granite; $3c_1$, orange to red-brown mottled aplite.

3b Fine to medium grained biotite ("Alaskite?") granite.

3a Diabase-gabbro multiple intrusions can contain up to 30% veins and stockwork of 3b.

VOLCANIC AND SEDIMENTARY ROCKS

HADRYNIAN - LONG HARBOUR GROUP

2 Mooring Cove Formation: fine red-brown tuff and layered welded ash-flow units.

1 Belle Bay Formation: felsic, pyroclastic and sedimentary rocks, felsic flows, and basalt flow.

1d Massive welded and layered ash-flow tuff, breccia, and nonwelded massive tuff.

1c Foliated to massive vesicular basalt flow, agglomerate, and/or diabase.

1b Foliated felsic breccia, tuff and flow, minor welded units and sediment: $1b_1$, purple breccia and minor flow, $1b_2$, gray, locally welded breccia; $1b_3$, bedded to laminated fine to coarse sediment; $1b_4$, dark green fine to medium grained massive waterlain tuff; $1b_5$, laminated to bedded fine silicic tuff phyllite and sericite schist: minor coarse breccia.

1a Massive buff to green nonwelded polylithic breccia, vesicular and/or feldspar porphyritic flow: $1a_1$, welded gray breccia with devitrification textures, $1a_2$, massive to bedded medium to coarse red and green sediment; $1a_3$, welded laminated ash flow.

SYMBOLS

2% pyrite, sericite alteration and gossanous .....

1-2% disseminated and stringer pyrite, may be gossanous .....

Hematite-limonite alteration .....

> 1000 g/t Sn assay, visible molybdenite and galena ..... Sn, Mo, Pb

Malachite stain related to minor chalcocite and bornite ..... Mal

Anomalous radioactivity, maximum 6 x background ..... R

Bedding (tops known, unknown) .....

Flow layering (inclined, vertical) .....

Foliation (inclined, vertical) .....

North of the Cross Hills pluton, rocks mapped as belonging to the Belle Bay volcanic formation and the Anderson Cove terrestrial metasediment formation (Bradley, 1962; O'Brien and Nunn, 1980) consist of a strongly foliated volcanic to volcanic sedimentary sequence (Unit 1b) comprised of coarse, locally welded, rhyolite breccias and tuff, waterlain tuff and sediment, slate, siltstone, quartz sericite schist, diabase and basalt flows (Unit 1c). These rocks exhibit rapid lateral and vertical facies variations. They appear to be in fault contact with a massive banded to brecciated ashflow unit (Unit 1d) containing minor (<2%) disseminated and fracture-filling pyrite which occurs along the southern contact of the Ackley Granite. In the western part of the map area, purple-brown ash flow and fine tuff units (Unit 2) of the Mooring Cove volcanics (Bradley, 1962) overlie purple welded to nonwelded massive to layered breccias, banded rhyolite, basalt flows, and minor siltstone.

Moderate to tight chevron folding of the layered tuff and siltstone and ash-flow banding occurs locally. This factor coupled with the massive nature of the rocks makes definitive structural and/or stratigraphic analyses of the volcanic sequence difficult. Both Bradley (1962) and O'Brien and Nunn (1980) suggest that large scale moderate to tight folding of the volcanic sequence has occurred along an east-northeast axis.

The Anderson Cove Formation is absent from the succession in this area which may suggest a local disconformity or unconformity.

Cross Hills Plutonic Complex (Unit 3)

Three main intrusive phases occur in the Cross Hills plutonic complex to the northwest of Grand Le Pierre. These are:

3a: A fine to coarse grained diabase-gabbro unit intrudes Precambrian volcanic rocks and is composed of multiple intrusions of diabase and gabbro. Veining by fine to pegmatitic gabbro is common.

3b: A fine to medium grained, orange, biotite, 'alaskitic,' miarolitic granite intrudes the diabase-gabbro and locally intrudes volcanic country rocks. Extensive stoping of the gabbro-diabase is common and vertical subparallel biotite granite dikes trending 070° to 080° occur near the southern margin of the gabbro-diabase unit.

3c: A fine to medium grained purple-brown, miarolitic, riebeckite granite occurs to the south and also above the biotite granite and has intruded the gabbroic and volcanic country rock. The riebeckite granite contains late fine grained veins, and tuffisite breccias related to gas-release from the crystallizing magma. Small granitic pegmatite patches are locally present. In the western part of the area mapped in detail, a mottled, orange-brown aplite unit with sharp vertical contacts occurs between the biotite granite and medium grained peralkaline granite. In the east the contact between biotite granite and peralkaline granite is marked by a gradual color change. The northern boundary of the medium grained peralkaline phase is noted by a decrease of 30 to 50% in background total count radioactivity.

Three areas of peralkaline granite to the north and east of the main exposure occur topographically above biotite granite and probably form the upper portion of east-northeast trending biotite granite dikes.

West of Grand Le Pierre, the Cross Hills complex appears to mark a phase

of south-southeast / north-northwest crustal extension with initial multiple intrusion of gabbro-diabase. Stoping and intrusion of the gabbro and diabase by biotite granite followed, and differentiation to form a roofward or marginal peralkaline phase occurred in the larger silicic magma chambers.

Preliminary investigation of the Cross Hills plutonic complex east of Grand Le Pierre indicates a comparable history with diabase being the more abundant mafic lithology stoping into volcanic country rock. East-northeast trending diabase dikes commonly intrude the Precambrian volcanic rocks. Fine to medium grained biotite granite is the predominant silicic lithology east of Grand Le Pierre with minor patches of peralkaline granite noted. A medium to coarse grained hornblende-biotite granodiorite with abundant volcanic and diabase xenoliths is confined to the eastern portion of the complex; it has intruded the main diabase unit, and has locally been intruded by gabbro and thin aplite dikes. The relationship between the hornblende-biotite granite and the biotite granite has not been observed. Diabase stoped by granite occurs at the Southeast Bight Hills.

Ackley Granite (Unit 4)

The Ackley Granite consists of fine to medium grained miarolitic quartz-feldspar porphyritic biotite granite in its southern exposures (Unit 4a) and grades northward into a medium to coarse grained biotite granite (Unit 4). Phenocryst content averages from 10 to 20%. A coarse porphyritic phase with 40 to 50% phenocrysts is host to the greisen veins southeast of Moulting Pond. Topographic relief over the granite is gentle with little exposure, whereas the volcanic country rocks to the south form rugged topographic features and are well exposed.

The granite contact varies from vertical to shallow with possible roof pendants present west of Anesty Hill and east of Moulting Pond.

MINERALIZATION AND ALTERATION, SAGE POND - GRAND LE PIERRE AREA (Figure 2)

Volcanic Sequence

Extensive sericite alteration, commonly with 1 to 2% disseminated and fracture-filling pyrite and local zones of up to 5% pyrite occur throughout the volcanic sequences in the area. Minor alteration with stockwork pyrite is a common feature marginal to the Ackley Granite and has been described from the molybdenite showings in the Rencontre area (Whalen, 1976), and probably resulted from late magmatic-hydrothermal processes associated with emplacement of the Ackley Granite. The pyritic alteration zones in the map area are in part related to the Ackley Granite. However, many of the pyritic zones may have a tectonic and/or synvolcanic origin. No base metal mineralization was observed; however, a potential exists for both gold mineralization and base metal mineralization within the volcanic sequence.

Peralkaline Granite - Cross Hills Plutonic Complex (Figure 2)

Throughout the peralkaline granite, zones of hematite and limonite stain occur with possible sericitic alteration and about 2 to 5% pyrite, and are developed over an area of 1000 by 200 m along the English Harbour road. Local 'veins' of gray-green, intense sericitic alteration have been noted over a strike length of 30 m and a width of 3 m. These veins contain 1 to 5% disseminated and fracture-filling pyrite with trace amounts of galena. The alteration is related to late east-northeast fractures and breccia zones in the pluton.

A zone of anomalously radioactive patches from 2 to 5 times background and trending 070° was noted in the granite

over a strike length of 100 m southeast of Bart Pond. Individual anomalous patches are less than 2 by 0.5 m in area and are related to hairline fractures near the granite roof. Several 2 m diameter areas of anomalous radioactivity to 6 times background were noted elsewhere and are associated with hairline fractures or late aplitic veins in the peralkaline granite.

Traces of chalcocite with minor malachite stain were noted in two separate quartz veins in late crosscutting quartz veins (maximum width 1 m) in the granitic phases of the Cross Hills plutonic complex.

A general metallogenic model would suggest marginal and roofward volatile and ore element concentration in a silicic magma chamber with potential mineralization (Nb, Zr, Sn. Th, F?) at or near the roof contact either as aplite or pegmatite sheets, or as veins in postconsolidation fracture zones. A possibility exists for economic mineralization in late crystallizing differentiates.

Quartz-Topaz Veins in the Ackley Granite

The main concentration of white, medium to coarse grained quartz-topaz veins occurs between Rabbit Pond and Gisborne Lake at and near the south contact of a fine to medium grained porphyritic marginal phase of the Ackley Granite. Quartz-topaz veins have been noted as far west as Long Harbour and have been observed within the granite up to 1 km from the contact. They increase in concentration and size southward with the largest quartz-topaz outcrops occurring at convex undulations of the granite contact. Veins are podiform-elongate with a predominant east trend (080-110°) and are generally less than 10 by 2 m in size; they form nobs of outcrop or subcutcrop in weathered granite till or in areas of weathered granite subcrop.

Subparallel quartz-topaz ± pyrite ± hematite ± fluorite vein swarms (fracture filling to 3 m wide veins) underlie massive quartz-topaz outcrop (50 by 6 m) at the Esso drill site southwest of Moulting Pond. Sericitization and bleaching (± pyrite) of the host orange-red granite quartz-feldspar porphyry is limited to within 1 m of individual veins and is generally narrower than vein width. Gray-green muscovite-quartz topaz greisen commonly occurs marginal to massive quartz-topaz but can occur as individual veins. Fine fracture networks are common in the unaltered granite host and minor disseminated pyrite may be present in granite near the veins.

South of Anesty Hill, quartz-topaz veins (± pyrite ± fluorite with occasional grains of molybdenite) outcrop over an area of 200 by 60 m within a convex south lobe of the granite. Gently dipping layering (20° to 40°S) defined by variation of topaz and quartz content suggests an area where fluorine-rich fluids were ponded near the granite roof. Rhyolite outcropping immediately south and west of the Anesty quartz-topaz body is strongly sericitized suggesting that the greisen zone may plunge to the south and west under the rhyolite.

A generalized model is envisaged in which fluorine- ± tin-rich magmatic fluids evolved from a rapidly crystallizing marginal granite phase and rose along east trending fractures in consolidated granite to collect in embayments at the granite margin and roof (see Dickson, 1983; Whalen, 1980). A potential exists for large tonnage, low grade stockwork deposits in addition to high grade vein and massive greisen deposits.

Minor Copper Occurrences, Grand Le Pierre Area

Minor malachite stain associated with chalcocite and/or bornite mineralization were noted (1) in sheared rhyolite breccia in the Cross Hills Fault

zone northeast of Bart Pond (Figure 2), (2) in rhyolite breccia approximately 5 m west of the contact of the granodiorite phase of the Cross Hills complex on the Grand Le Pierre - Terrenceville road; and (3) in rhyolite on the west side of the English Harbour road at the southwest limit of the area mapped (Figure 2). These could all best be ranked as past producers.

OTHER OCCURRENCES OF ALTERATION AND MINERALIZATION - FORTUNE BAY AREA

(i) Several beryl crystals up to 3 by 1 cm were noted in a 50 by 20 cm quartz pocket in the fine grained phase of the Ackley Granite to the southeast of Big Blue Hill Pond (UTM 343 467, 1M/14).

(ii) Three molybdenite flakes (up to 1 cm) were noted in a roadside quartz vein on the east margin, and fluorite veinlets were observed near the western margin of the Berry Hill Stock.

(iii) Silicified and/or sericitized zones (in fine grained Precambrian tuff and sediment) with 1 to 5% disseminated and/or stringer pyrite were noted over a width of up to 70 m on the Monkstown road (east of the Burin Highway). Minor fine grained chalcopyrite may be locally present. Other pyrite occurrences are present on the Burin Highway. These may represent synvolcanic hydrothermal exhalative or subvolcanic epithermal processes, and a potential for base metal and/or gold mineralization is evident.

(iv) Molybdenite occurrences reported at Hungry Cove Pond and at Spout Brook, and a Mo-Bi showing at Big Blue Hill Pond (Anderson, 1965) could not be located. A vertical quartz vein with maximum dimensions of 1.5 m by 5 cm containing minor pyrite and possible trace wolframite was observed at the Big Blue Hill Pond locality.

(v) Swarms of narrow, subvertical quartz-muscovite "greisen?" veins were noted at two localities southeast of Big Blue Hill Pond (UTM 356 937 and 364 948; 1M/14). Veins observed have a maximum dimension of 30 cm by 10 m and trend 060° to 070°. A maximum vein density of 2 to 3 per metre is present.

ACKNOWLEDGEMENTS

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COMPUTER-AIDED ANALYSIS OF LITHOGEOCHEMICAL DATA FROM NEWFOUNDLAND GRANITES AND ITS ROLE IN MINERAL EXPLORATION

by

P.H. Davenport, J. Tuach and W.L. Dickson

INTRODUCTION

Geochemical indicators have been used by many workers to distinguish mineralized from barren granitoid plutons. Some of these geochemical indicators have been regarded as of local or regional value, while others have been touted as having global significance. The first large scale attempt at assessing the mineral potential of some Newfoundland granitoids through their geochemistry was that of Strong et al. (1974). Subsequently, detailed studies have been made with a more systematic sampling approach by Elias (1980) of 14 plutons in the Bay D'Espoir area, Dickson (1983) of the Ackley Granite, and Blackwood and Green (1982) of the Middle Ridge Granite. In addition, there are several studies in progress which include granitoid geochemistry.

GRANITE GEOCHEMISTRY DATA FILE

To fully utilize these geochemical data to assess mineral potential, they are being organized into a computer file containing field observations as well as geological and chemical information. Currently, this file contains data from 1243 samples collected from 21 plutons. For all samples, the following information is recorded: sample number, pluton, U.T.M. coordinates, rock type, age, physical characteristics (color, grain size, texture, banding, alteration), fabric, composition of mafic minerals, presence or absence of sulfides, garnet, tourmaline, beryl, fluorite and muscovite, as well as major element data. The trace elements suite for most samples is Li, Be, F, V, Cr, Ni, Cu, Zn, Ga, Rb, Sr, Y, Zr, Nb, Mo, Ba, Pb, Th and U. Sn and W have been determined on selected samples.

USES OF DATA FILE

After the data are assembled into an organized computer file, it becomes very easy to test on Newfoundland granites for "geochemical indicators" of mineralization developed by other workers elsewhere. It is apparent, for example, that the concept of S and I type granites does not apply well to the granitoids of southeastern Newfoundland (e.g. Dickson, 1983), so this concept is of little use here. In addition, it is easy to carry out various multivariate statistical procedures on the data to gain a better understanding of the interrelationships present and, hence, to gain some insight into geochemical processes. Finally, computer graphics can be used to examine the data through both standard petrological diagrams and areal plots of the data and derived variables.

An illustration of the application of the analysis of a geochemical computer data file to mineral exploration can be provided for the Ackley Granite. This was systematically sampled on a 2 x 2 km^2 grid and geologically mapped by Dickson (1983). The known mineral occurrences in the Ackley Granite are shown in Fig. 1, and plots of Sr and Ba for

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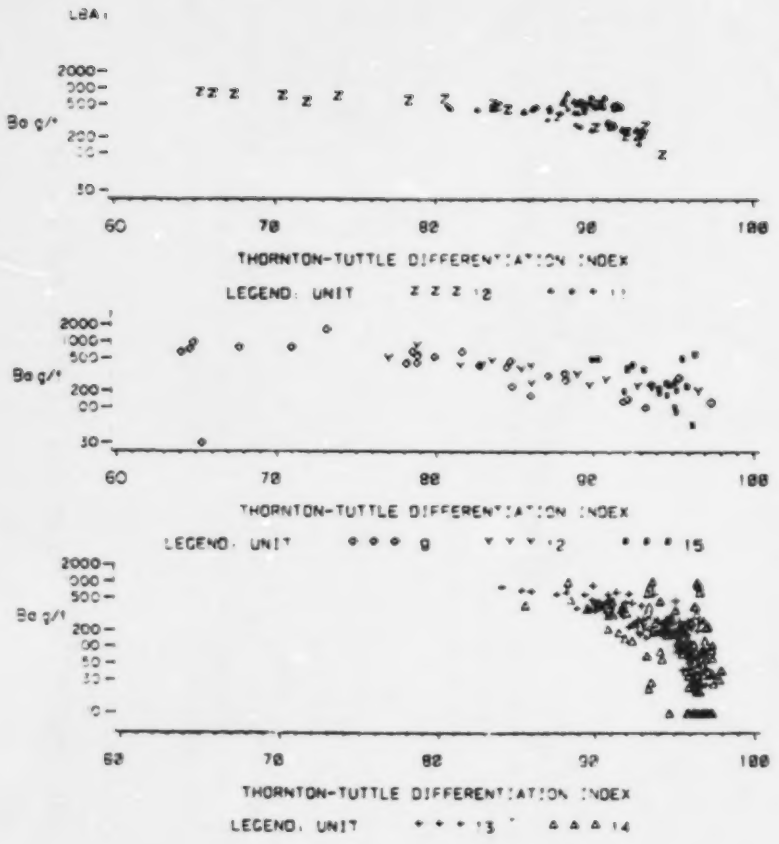


Fig. 1a: Barium trends with differentiation index for the Ackley Granite (from Dickson, 1983). Note logarithmic scale for Ba.

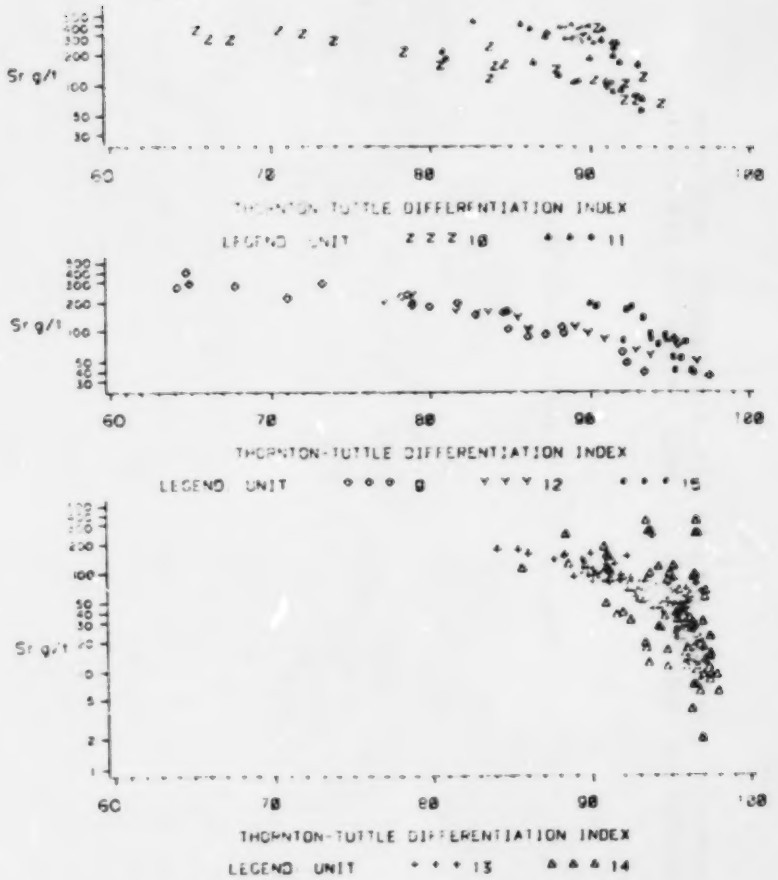


Fig. 1b: Strontium trends with differentiation index for the Ackley Granite (from Dickson, 1983). Note logarithmic scale for Sr.

See Fig. 2 for key to units of the Ackley Granite.

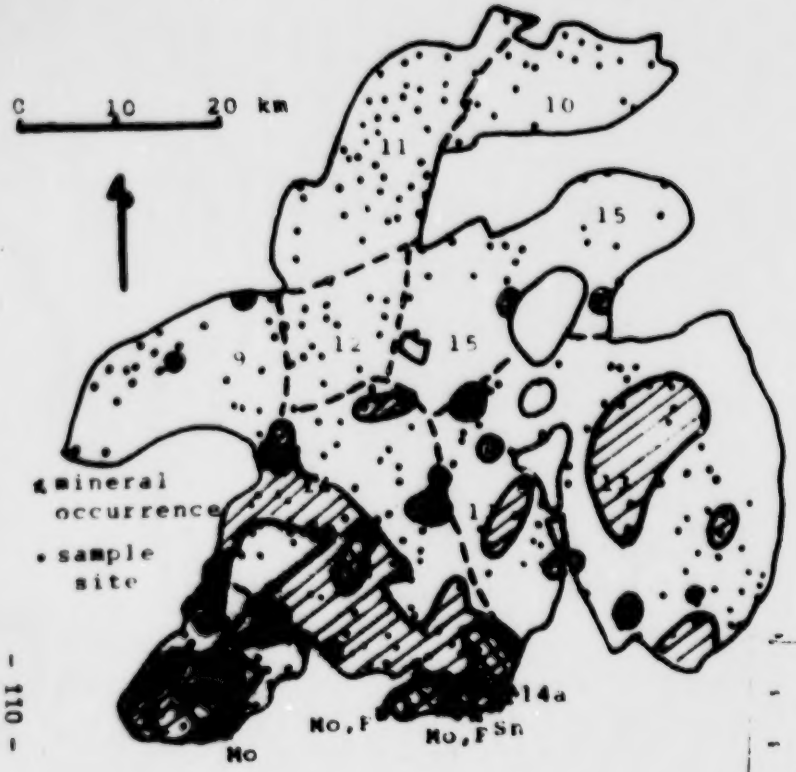
units 13 and 14 and shown in Fig. 1a and 1b (from Dickson, 1983). Both Sr and Ba show extreme depletion in some samples from unit 14, which contains the known Mo and Sn mineralization. Plots of Ba and Sr superimposed on the geology map show that the extreme depletion in these elements forms a halo around the showings (Figs. 2a, 2b). All other data were plotted in this way for the 357 grid samples, and showed a variety of coherent trends when contoured.

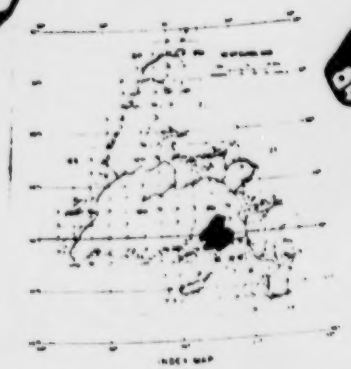
To try to summarize the plots of the 11 oxides and 20 trace elements and a number of ratio plots, R-mode factor analysis was carried out. This mathematical procedure is also known as principal components analysis, and in this application the technique is used to produce a relatively manageable number of variables from the 31 major oxides and trace elements. The first factor or principal component is a linear combination of these 31 variables chosen to account for more of the variance of the data than any other linear combination. The second factor is then chosen to account for more of the remaining data variance than any other combination of variables and so on. Each factor is chosen to be independent of (or orthogonal to) the previous factors. In theory a number of factors equal to the number of variables can be extracted, but the purpose of the method is to account for most of the observed variation by means of a few (perhaps four to six) factors. The calculation of the factors is an objective mathematical process, but the selection of the model to use (i.e. the number of factors) is subjective. Table 1 gives an example of a four-factor model for the Ackley Granite. The first and second factors account for over 50% of the total data variance and are the most readily explained geologically. Factor 1 can be related to normal geochemical trends in a differentiated comagmatic suite of rocks, with SiO_2 varying antipathetically with MgO, Al_2O_3, FeO, Fe_2O_3, TiO_2, MnO, P_2O_5 and the trace elements V, Sr, Ba and Zn. This factor accounts for over 38% of the total "geochemical variance" in the granite.

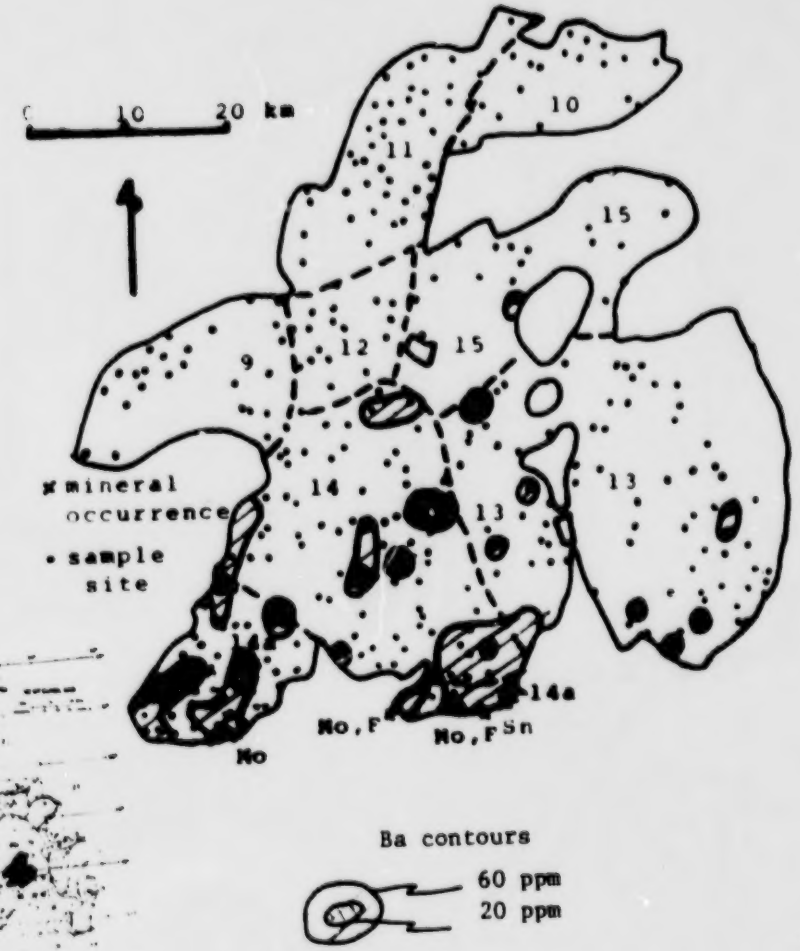
Factor 2 is a combination of the lithophile trace elements Nb, Rb, U, Th, Y, Be, Li, Sn, together with Ga and F. This factor also has negative loadings on Sr and Ba. Concentration of these elements is typical in the upper part of a silicic magma chamber (e.g. Hildreth, 1981; Strong, 1980), with depletions of Sr and Ba. In fact, in a qualitative way, it is possible to construct a pseudo-enrichment/depletion diagram to compare with the relative enrichment diagram for the Bishops Tuff of Hildreth (1981). The correspondence in sense of elements variations is striking (Fig. 3).

The other two factors in this model are of less interest, and factor 4 is dominated by a single variable Na_2O, and, therefore, does not contain much more information than the variable Na_2O itself.

The importance of the contribution of each oxide or element to the factor is given by the factor loading. This may vary from -1.0 to 1.0 and can be thought of as a regression coefficient. In Table 1, only elements with loadings of a magnitude greater than 0.5 for any element are listed for each of the six factors. From these loadings a factor score can be calculated for each sample. Thus, for factor 1, a low, negative score will be generated for a sample high in SiO_2 and low in MgO, TiO_2, etc. (i.e. a highly differentiated granite), whereas high positive scores will be assigned to more mafic samples. Similarly, with factor 2, high positive scores will result in samples high in lithophile elements, Ga and F, and low in Ba and Sr. If the geochemical significance of factor 2 is related to the concentration of these elements at the top of the granite body, the high positive scores should form a coherent pattern which would delineate this zone of concentration.







SUBDIVISIONS OF ACKLEY GRANITE: 15 - undivided, massive, biotite granite; 14 - massive, uniform, coarse grained, biotite granite; 14a - medium grained, slightly porphyritic equivalent; 13 - massive, porphyritic, coarse grained, biotite granite; 12 - massive, porphyritic, medium grained, biotite granite; 11 - massive, porphyritic, medium to coarse grained biotite ± muscovite granite; 10 - massive porphyritic, coarse grained, biotite granite; 9 - massive, porphyritic, medium to coarse grained, biotite ± hornblende granodiorite.

Fig. 2a: Strontium depletion patterns in the Ackley Granite.

Fig. 2b: Barium depletion patterns in the Ackley Granite.

Table 1: Four-factor model for the 357 grid samples from the Ackley Granite. The factor model was subjected to a variance rotation. Only factor loadings with a magnitude greater than 0.5 have been listed.

	Factor 1	Factor 2	Factor 3	Factor 4
	- SiO_2 (-0.88)	Nb (0.81)	Pb (0.76)	Na_2O (0.79)
	MgO (0.89)	Rb (0.79)	K_2O (0.60)	
	TiO_2 (0.88)	U (0.76)		
	P_2O_5 (0.87)	Th (0.73)		
	V (0.84)	Y (0.72)		
	MnO (0.82)	Be (0.64)		
	Al_2O_3 (0.81)	Ga (0.58)		
	Sr (0.71)	Li (0.55)		
	Ba (0.69)	F (0.55)		
	Zn (0.68)	Sn (0.54)		
	Sr (0.57)	- Sr (-0.55)		
	FeO (0.54)	- Ba (-0.57)		
	Fe_2O_3 (0.51)			
% of variance:	38.3	12.9	5.8	4.9

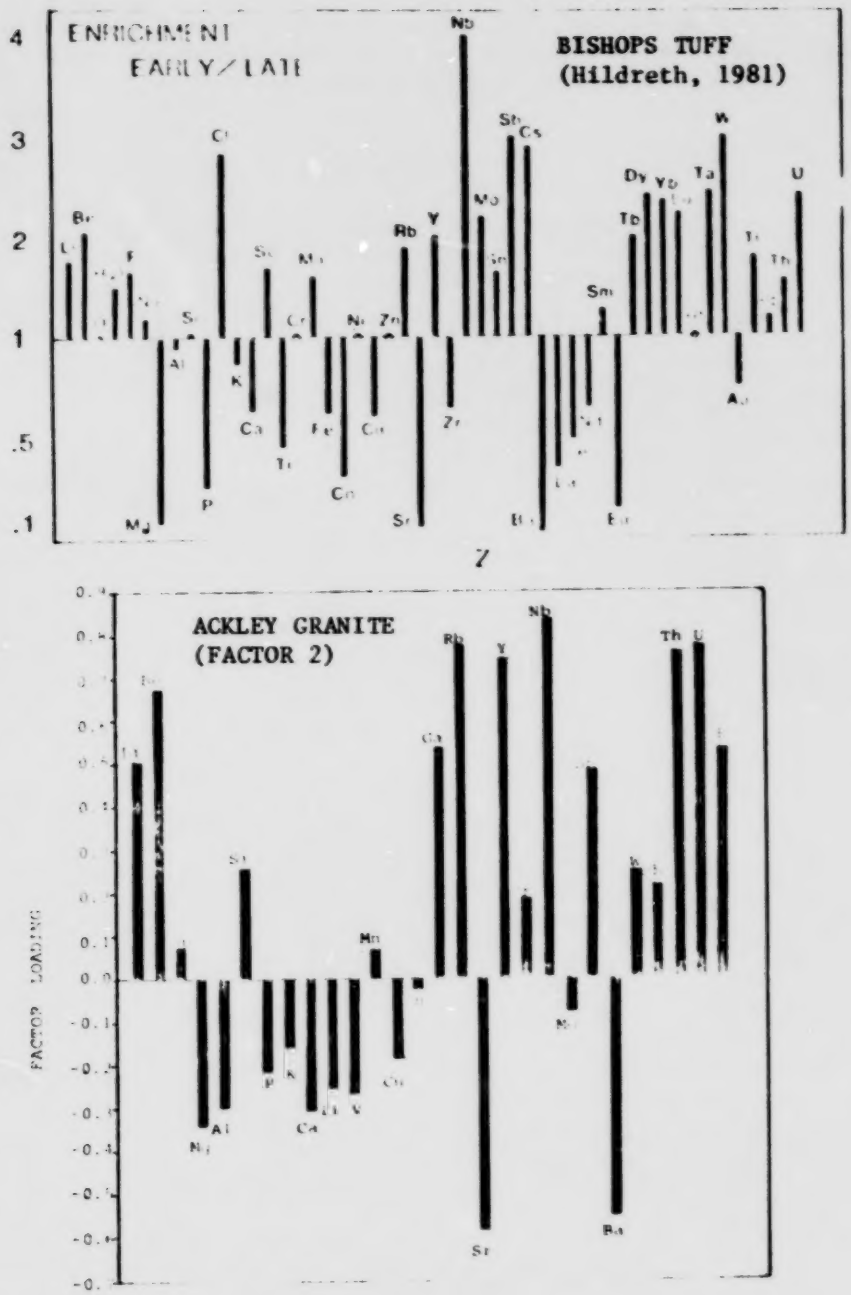


Fig. 3: Plot of factor 2 loadings for the Ackley Granite (below) for 28 of the 31 chemical variables (Feo, Fe_2O_3, and LOI omitted) compared with enrichment/depletion plot for Bishops Tuff (Hildreth, 1981). The factor loadings are correlation coefficients of the variables with the factor; elements having a large positive loading (0.5-1.0) contribute strongly and positively to the factor; loadings between 0.5 and -0.5 indicate modest to minimal contributions, and loadings in the range -0.5 to -1.0 are for those elements with a strong negative contribution. The correspondence in sign and relative magnitude between the factor 2 loadings for the Ackley Granite and the enrichment (+) and depletion (-) factors for the early (top of magma chamber) and lower (deeper in magma chamber) units of the Bishops Tuff are striking, and suggest similar processes were operative in both magma chambers.

The factor scores from factors 1 and 2 are plotted in Figs. 4 and 5. The following points are noteworthy:

(1) the factor scores do show coherent patterns;

(2) Factor 1 scores are lower (i.e. SiO_2 is higher and Al_2O_3, MgO, TiO_2, etc. are lower) in the southeastern half of the pluton. This may reflect an inherited compositional difference in source material since the two parts of the granite as defined by factor 1 are separated by a line which lies close to the projected line of the Dover - Hermitage Bay fault zone, with the Gander Zone lying to the northwest and the Avalon Zone to the southeast.

(3) Factor 2 scores show a cross-cutting north-northwest to south-southeast trend. High values of this factor (indicating enrichment in Sn as well as Nb, Rb, U, Th, Y, Be, Li, and F) surround the known Sn-bearing greisen zones, and extend in a west-southwest trend to include the Mo-Bi showing at Big Blue Hill Pond (line A-B in Fig. 5). Small greisen veins were discovered within the central part of this trend near site C (see Tuach, this volume).

(4) The area of Mo showings west of Long Harbour shows only moderately high scores for factor 2, suggesting that this southwestern lobe of the granite may be different from the Sn-bearing south-central margin of the granite. The mineralization in this southwestern lobe is not Sn-bearing, but it is reflected by a halo of Sr and Ba depletion. There are also differences in F content of the two marginal phases (unit 14a).

CONCLUSION

This simple example of a computer-aided analysis of the lithogeochemical data from the Ackley Granite shows the potential power of this approach. Such an analysis presupposes the existence of a sample suite from a well designed field sampling scheme, and the organization of the data in a computer file.

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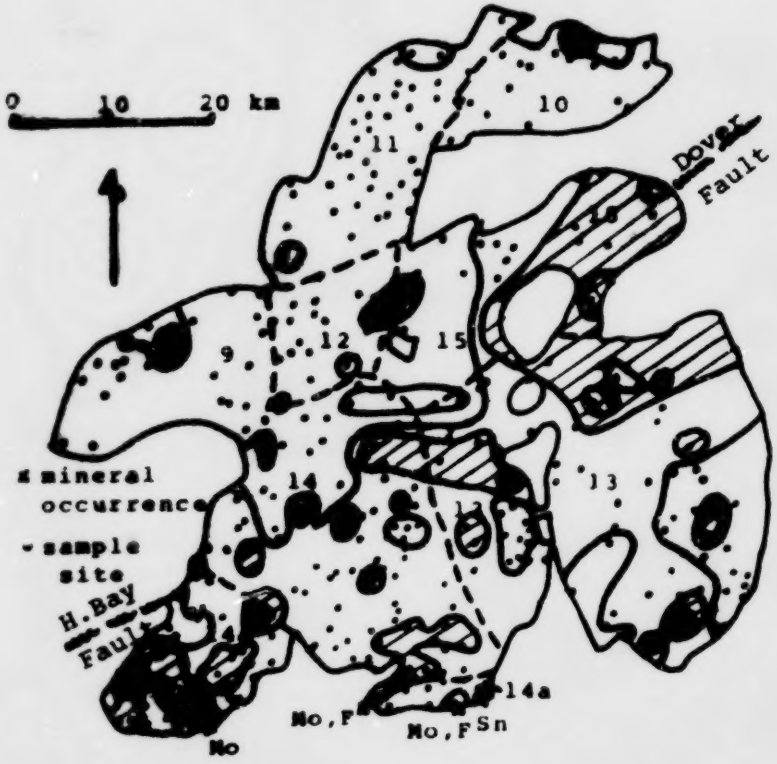
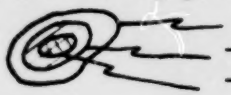
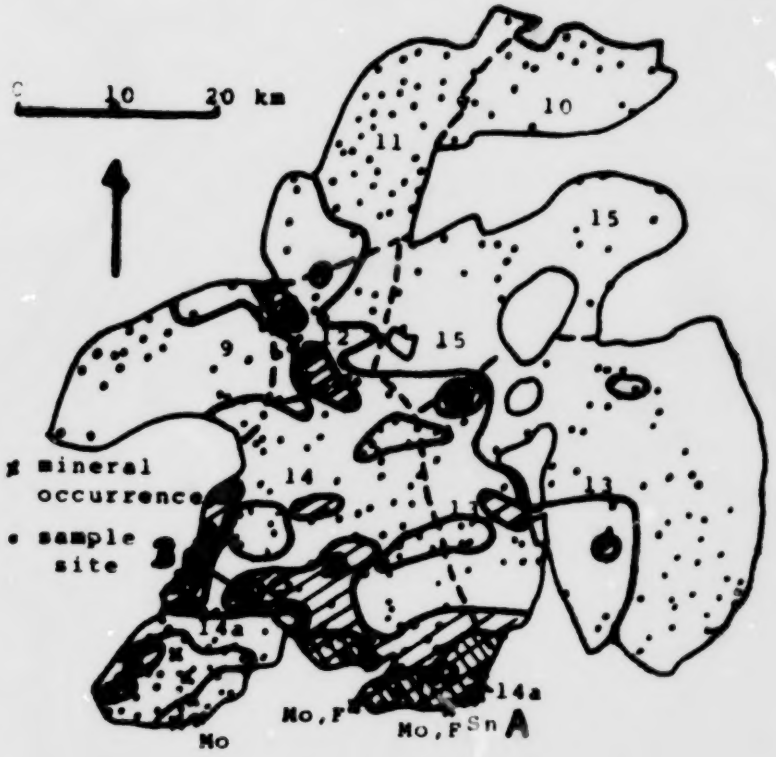


CONTOUR LEVELS FOR FACTOR I (-SiO_2, +TiO_2, MgO, P_2O_5, MnO, Al_2O_3, FeO, Fe_2O_3, V, Sr, Ba, Zn, Zr)



0.0 std. dev. units
-0.75
-1.5



CONTOUR LEVELS FOR FACTOR 2 (+Nb, Rb, U, Th, Y, Be, Ga, F, Li, Sn; - Sr, Ba)

0.0 std. dev. units
0.75
1.5

SUBDIVISIONS OF ACKLEY GRANITE: 15 - undivided, massive, biotite granite; 14 - massive, uniform, coarse grained, biotite granite; 14a - medium grained, slightly porphyritic equivalent; 13 - massive, porphyritic, coarse grained, biotite granite; 12 - massive, porphyritic, medium grained, biotite granite; 11 - massive, porphyritic, medium to coarse grained biotite ± muscovite granite; 10 - massive porphyritic, coarse grained, biotite granite; 9 - massive, porphyritic, medium to coarse grained, biotite ± hornblende granodiorite.

Fig. 4: Distribution of Factor 1 scores in the Ackley Granite.

Fig. 5: Distribution of Factor 2 scores in the Ackley Granite.

Eastern Newfoundland

BARITE EVALUATION IN THREE AREAS OF SOUTHEASTERN NEWFOUNDLAND

by

A.F. Howse and C.J. Collins*
Mineral Deposits Section

Introduction

An evaluation of the barite potential of the western Avalon Peninsula continued during the summer of 1983. This assessment consisted of a regional stream sampling and prospecting program in two main areas of interest (Figure 1): (1) the eastern section of the Avalon Isthmus between Southern Harbour railway station in the north and Normans Cove in the south, an area underlain mainly by late Precambrian volcanic and sedimentary rocks, and (2) the St. Brides area of the Cape Shore, from Cape St. Mary's to Angels Cove, an area underlain by Hadrynian and Lower Cambrian sedimentary rocks. Prospecting along streams was carried out in conjunction with sampling. The stream sediment survey on the Avalon Isthmus was coordinated with a similar project in an adjacent area by Butler (see report in this volume), who carried out geochemical follow-up of lake sediment anomalies that had been identified by a 1975 regional survey (Davenport et al., 1975). The results will be made available as an open file release after the analyses are completed.

A major sampling program was also carried out on known fluorspar veins in the St. Lawrence area of the Burin Peninsula, with particular emphasis on those veins known to contain associated barite. Forty veins were examined and sampled.

Isthmus of Avalon

A stream sediment survey was done along the eastern section of the Avalon Isthmus between Southern Harbour railway station in the north and Normans Cove in the south. The regional geology of the area was mapped and described by McCartney (1967). The oldest rocks there are marine sediments and tuff of the Connecting Point Group, which underlie the northwest part of the study area. Basaltic and rhyolitic volcanics of the Bull Arm Formation unconformably overlie the Connecting Point Group, and comprise the central and northeast section of the survey area. The Bellevue Peninsula and Collier Point are underlain by sedimentary rocks (mainly green arkose, siltstone and minor conglomerate) of the Hodgewater Group. South of the Bellevue Peninsula and west of Chapel Arm, the survey area is underlain by quartzite of the Random Formation and Lower Cambrian red and green shales and nodular limestone.

Barite veins are widely distributed throughout the area and were the subject of a Department Mines and Energy survey in 1982 (Howse and French, 1983). The best known vein, at Collier Point, is of commercial interest and is presently being developed, while the potential of other areas (notably the Bellevue Peninsula) for hosting veins of high grade barite is being recognized. All docu-

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mented occurrences of barite, with the exception of some minor showings exposed in road cuts, are on the coast.

The 1983 stream sediment survey represents an effort to assess the barite (and base metal) potential inland. Prospecting for mineralized float and outcrop was also an integral part of the stream traverses.

360 samples were collected, as uniformly as possible, at approximately 400 m intervals along the streams. Duplicate samples, for field control purposes, were taken at every twentieth sample site. A special effort was made to collect only active silt and to avoid, where possible, organic-rich material. The samples were dried and sieved to minus 80 mesh (<180 um) and are being analyzed for Ba, Sr, Cu, Pb, Zn, Ag, Fe. Mn and L.O.I..

Mineralization

A new barite-galena vein was discovered in sedimentary rocks of the Connecting Point Group about 2 km east of Little Southern Harbour. The vein is located midway between the east shore of Little Southern Harbour and the Trans Canada Highway immediately upstream from the water supply dam (approximate UTM grid reference: 5288700 N, 279850 E). The vein, which appears to lie along a brecciated fault zone, strikes northeasterly and is nearly vertical. It has a maximum width of about 80 cm but appears to pinch out rapidly on both sides of the stream in which it is exposed. The barite and associated galena occur as pods, blebs and stringers within the fractured and brecciated host rock. One such pod, about 20 cm in width but wedging at depth, contains an estimated 60% barite and 40% galena. Calcite also is present as a minor constituent. The galena usually occurs as coarse crystal aggregates in a barite and calcite gangue, but isolated patches were also observed. The mineralization could not be traced beyond the banks of the stream because of overburden.

On the Bellevue Peninsula, numerous barite veins were discovered along a 1200 m length of the stream which flows northward into Tickle Cove (Figure 1). The veins pinch and swell from a few centimetres up to 1 m in thickness. They are steeply dipping and the strike varies from 0° to 025°. The host rocks are grayish black siltstones. The barite is pink and white, and quartz is sometimes present. Barite float is also widely scattered along the stream bed. All of these barite occurrences appear to be part of a northward trending system of subparallel veins, the most northerly expression of which is exposed along the south shore of Tickle Cove.

Seven barite veins ranging in width up to 30 cm were identified in two rock cuts on the railway line about 1 km east of Jacks Pond provincial park. The veins are vertically dipping and all trend in a northeast direction. The barite is pink in color and consists of coarsely bladed crystal aggregates. The host rocks are highly sheared and altered. northwest dipping sediments of the Connecting Point Group.

Cape Shore - St. Brides

A stream sediment survey was carried out in the St. Brides area of the southwestern Avalon. The sampled area includes several barite prospects, nearly all of which are exposed on the coast.

231 samples were collected from a 110 km^2 coastal strip between Cape St. Mary's and Angels Cove. Streams in this area generally flow in a westerly and southwestern direction across sedimentary formations which range in age from Hadrynian to Lower Cambrian. The samples were taken from active sediment at approximately 400 m intervals. Duplicate samples were collected routinely at every twentieth sample site to allow a quantitative assessment of sample variance to be estimated. The samples were dried and sieved to minus 80 mesh (<180 um) and are being analyzed for Ba, Sr, Cu, Pb, Zn, Ag, Fe, Mn and L.O.I..

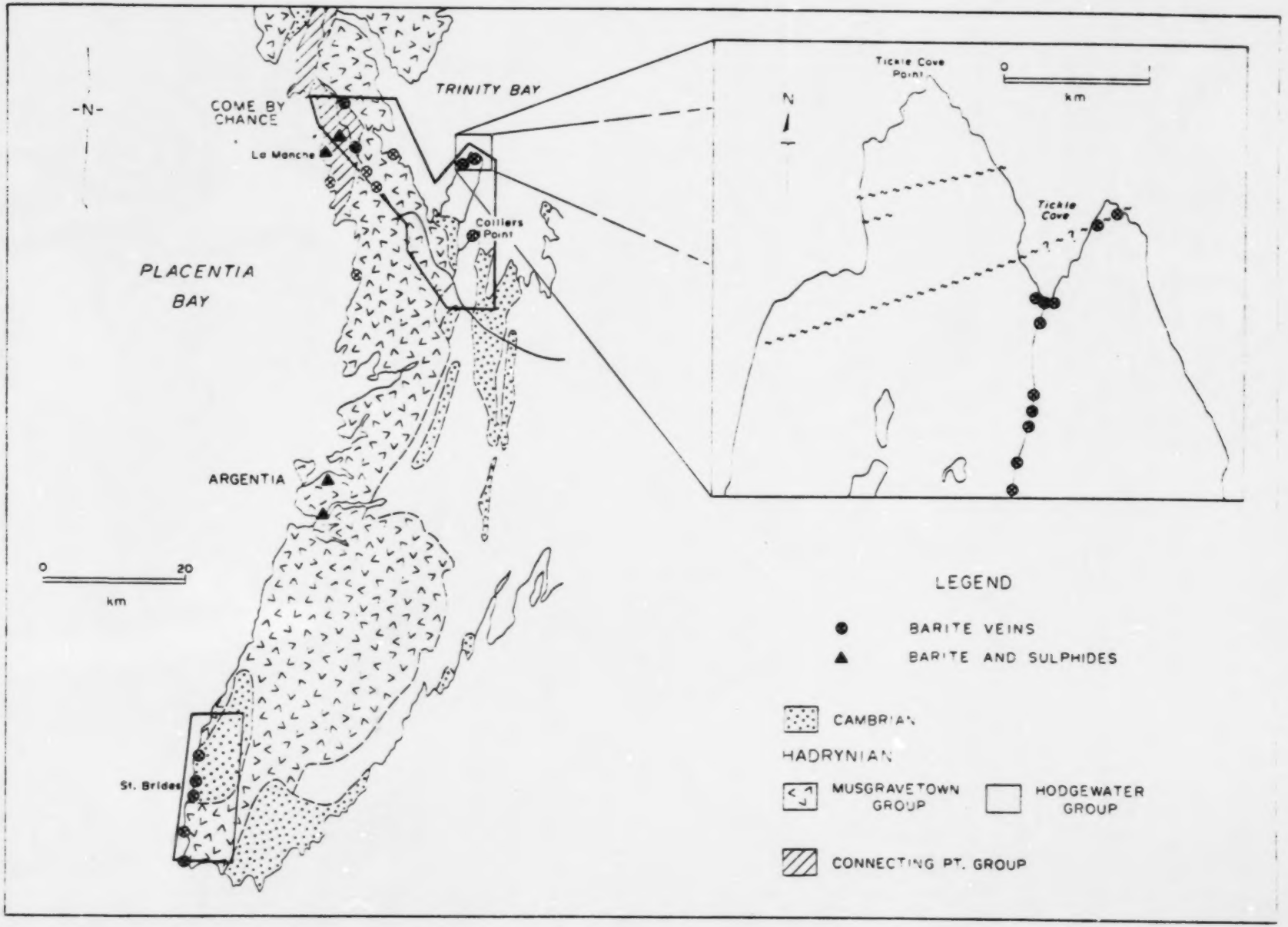

Figure 1: *Western Avalon showing project areas; insert shows barite occurrences on the Bellevue Peninsula.*

Mineralization

Several minor occurrences of barite were noted during the stream survey. Barite float found in a tributary which flows southward into Cuslett Brook was traced to its source, which consists of poorly exposed veins, <10 cm wide, cutting red mudstone. Similar barite veining occurs in a road cut on Route #8 about 500 m west and along strike from the stream occurrence.

St. Lawrence Area

During the 1983 field season, a major rock sampling program was carried out on the known fluorspar veins in the St. Lawrence area. The main purpose was to assess the barite potential of vein deposits of fluorite-barite mineralization. Samples were also collected for use in a B.Sc. thesis study (being conducted at Memorial University of Newfoundland by C.J. Collins) on some aspects of the genesis of the ore deposits.

A total of 40 veins and showings were examined (Figure 2) resulting in the collection of more than 250 samples. Wherever possible, continuous sections were sampled across the entire width of the veins or as far as exposure would allow. Some veins and showings were sampled using grab samples of outcrop wherever possible. Some veins were not exposed at all, so there it was necessary to take grab samples of float or dump (trench or workings) material.

Conclusions

680 silt samples were collected from two project areas on the western Avalon Peninsula. In addition, more than 300 rock samples were collected from various veins and occurrences, including those in the St. Lawrence fluorspar district of the Burin Peninsula. Several new barite veins were discovered on the Avalon Peninsula, including a new barite-galena vein near Southern Harbour. Analyses of the stream sediment data will be released in 1984.

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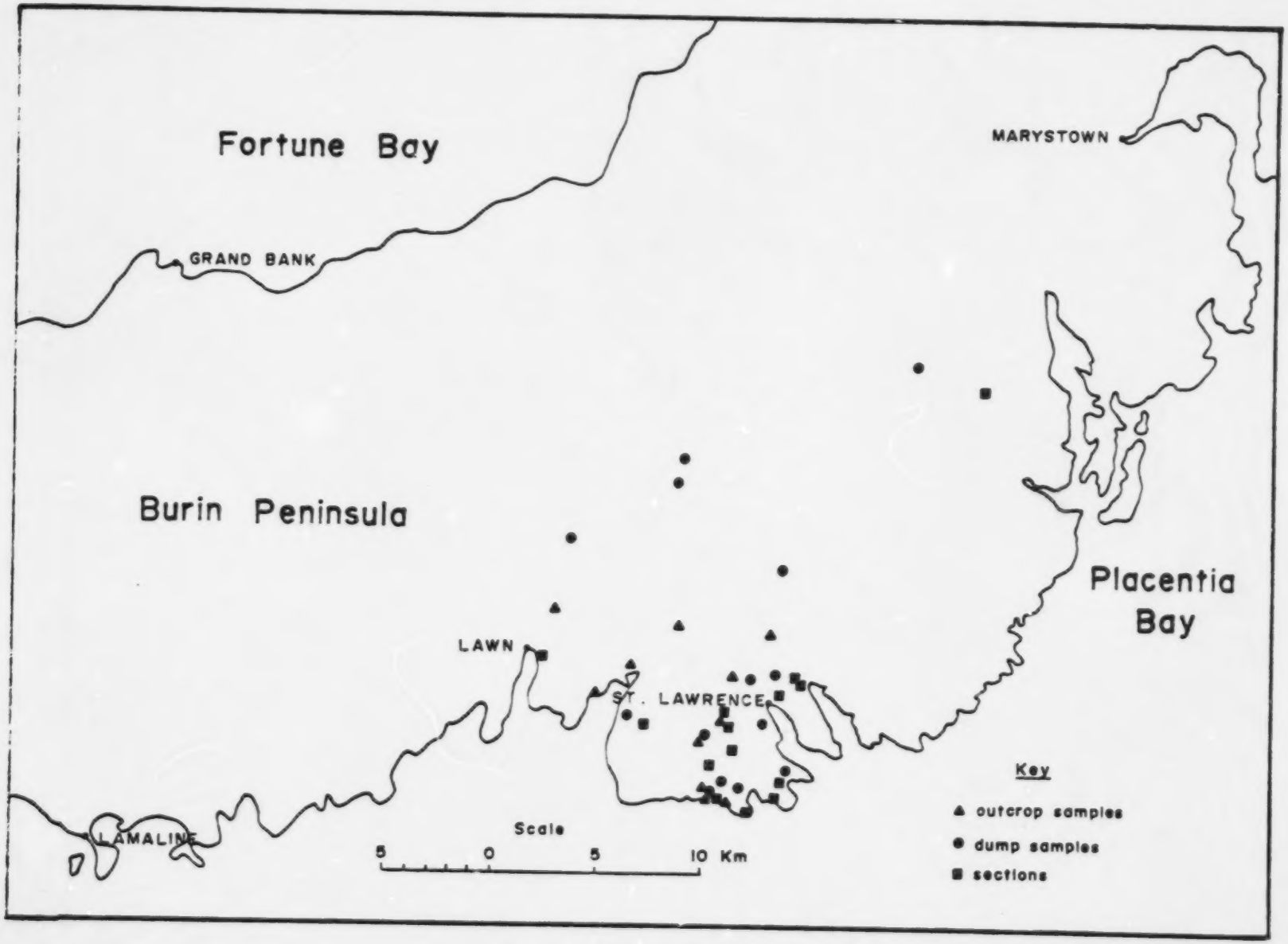

Figure 2: *Sample sites, St. Lawrence area.*

GEOCHEMICAL FOLLOW-UP STUDIES

IN

EASTERN NEWFOUNDLAND

by

James Butler
Geochemistry Section

Geochemical follow-up studies were conducted in four areas of nongranitoid terrain in eastern Newfoundland (see Map) during the summer of 1983. These areas included a zinc anomaly near the town of Harbour Grace (A), an extension to the area studied by Dean and Meyer (1983), a copper anomaly on the isthmus of Avalon (B) east of the village of Fair Haven (this study complements a similar study done by Howse (this issue) in the immediate area); a cobalt and minor lead anomaly near Bonavista (C) on the Bonavista Peninsula; and a multielement (predominantly nickel) anomaly in the Benton area (D) northeast of Gander. In each of these areas, sediment samples were collected, generally at 300 m intervals along all streams, at stream junctions, and at connecting streams between ponds. In the Fair Haven and Harbour Grace areas, water samples were also collected from the stream and the pH of the water was read on site using a pH paper of intermediate range (4-7) and in the laboratory using a pH meter. The stream sediment samples were analyzed for Cu, Pb, Zn, Co, Ni, Ag, Mn, Fe, Mo, F and L.O.I. (loss on ignition). The water samples were analyzed for Cu, Zn, Mn and Fe. In the Benton area, in conjunction with the collection of stream sediment samples, a Quaternary mapping project was conducted by members of the Environmental Geology Section (Vanderveer, this issue) and a geophysical gravity survey was carried out with the cooperation of Dr. H. Miller of the Department of Earth Sciences of Memorial University (this issue).

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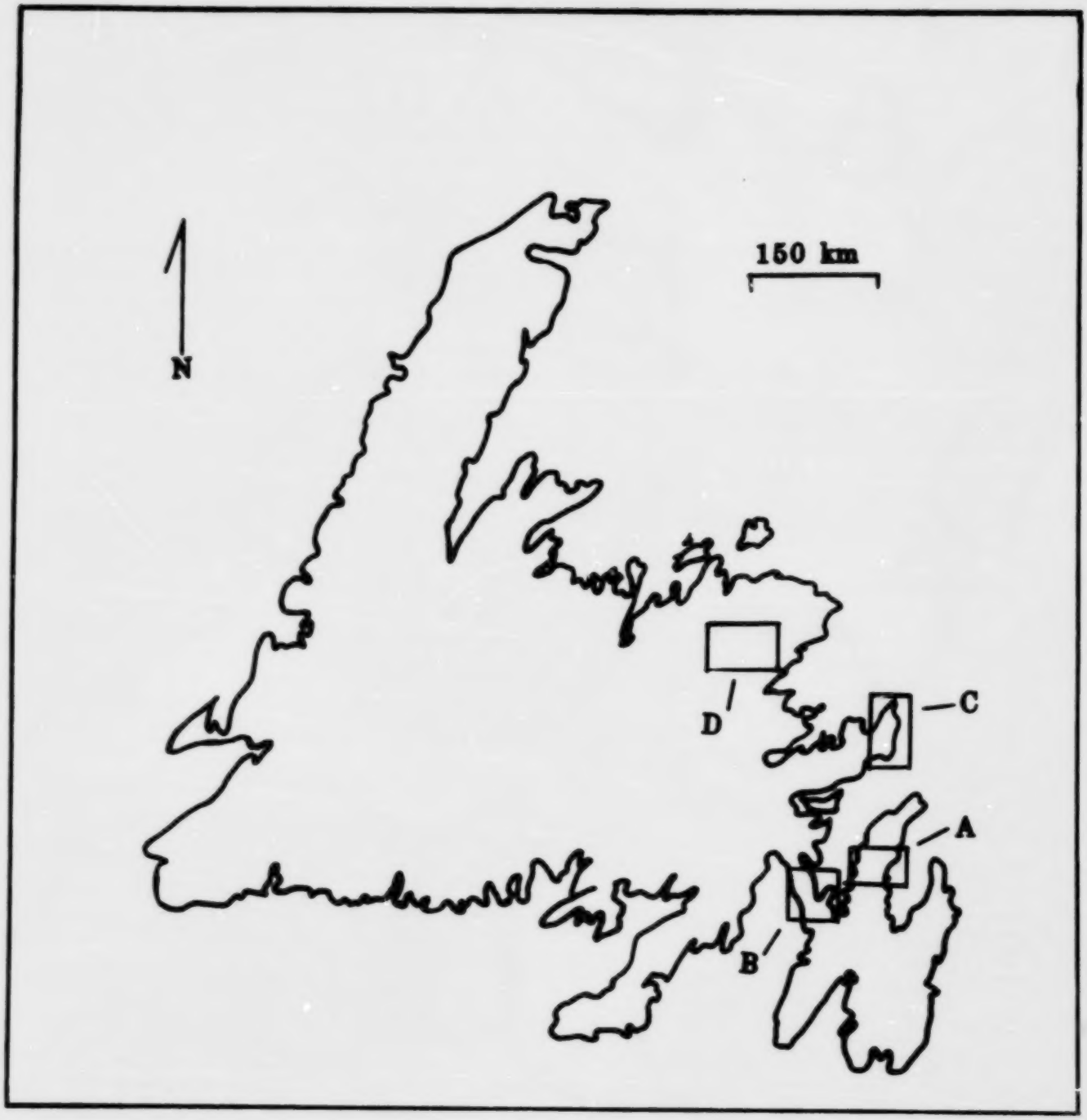

Figure 1: *Index map showing areas studied in the geochemical follow-up surveys, 1983: (A) Harbour Grace; (B) Fair Haven; (C) Bonavista; and (D) Benton.*

QUATERNARY GEOLOGY OF THE AREA NORTHEAST OF GANDER, NEWFOUNDLAND

by

D.G. Vanderveer and M.J. Batterson
Environmental Geology Section

Introduction

The area to the northeast of Gander has generated considerable interest due to geochemical anomalies revealed by a regional lake-sediment geochemistry survey.

Detailed follow-up studies of geochemistry surveys were carried out this summer (Butler, this volume). The till sampling program initiated by the authors is intended to supplement that program as part of the continued support to the mineral exploration industry by Quaternary geology (e.g. Vanderveer 1982a, 1982b).

From a regional Quaternary perspective, the area is also significant, being within the 'outer drift zone' described by Jenness (1960), although no field work was conducted in the area. The current project was therefore designed to provide a preliminary insight into the regional Quaternary sequences throughout the area. Previous to this, the only systematic Quaternary assessment of the area has been an aerial photographic interpretation of 2E/8, 2F/4 and 2F/5 conducted by the Environmental Geology Section.

Study Area

The field area is defined by the Gander Bay road to the west, the Trans Canada Highway on the southwest and the coastline to the east and north (Figure 1). Due to the confines of time and the distribution of the geochemical anomalies, work was concentrated on 2E/1 and 2D/16 (north of the Trans Canada Highway), supplemented by some sampling on 2D/9 and 2F/4.

Office Program

This phase of the study essentially consisted of a detailed Quaternary (landform) aerial photographic interpretation of the area not previously covered, i.e. 2E/1 and 2D/16. Many of the decisions concerning sampling locations and densities were based on this interpretation.

Field Program

This phase concentrated on providing as dense a data coverage as possible, with the aims of defining the geochemical pattern in the tills, describing the distribution of drift across the area, and assessing the possibility of mineralization from the Gander River Ultramafic Belt being dispersed throughout the area. The field program was composed of three distinct phases:

1) Road surveys. This survey was largely confined to the margin of the field area, where an adequate road system exists. Towards the centre of the region (i.e. the 2E/1 map sheet), few roads are present. At some sites, elements of glacial erosion were described, while at others glacial/proglacial depositional sequences were described and sampled. At most sites, profile till sampling of at least the B horizon, B-C transition, and C horizon was undertaken for grain-size and geochemical analysis. Pebble samples were also taken from the C horizon wherever possible for lithological analysis. In the more northerly parts of 2E/1, frost boils were often sampled because of the bouldery nature of the drift.

2) Backhoe testpits. Sites for testpitting were defined by the road survey and aimed to provided a greater amount of detail concerning Quaternary stratigraphies. In total, 15 testpits were dug in the area. Bag samples and pebbles were taken either from each stratigraphically defined unit or at 1 m intervals where no stratigraphy was revealed.

3) Helicopter survey. Due to the lack of road access to large parts of the field area, a helicopter program was initiated to provide data on a systematic basis across 2E/1 and 2D/16. Based on the previously described aerial photographic analysis, it was decided that whenever possible a grid spacing of 3000 m by 3000 m for sample sites would be utilized. At each site, profile sampling was attempted, although the C horizon was rarely reached due to either the bouldery nature of the upper surface or the wetness of the terrain.

In total, 369 samples were collected from 179 sites across the field area.

Results of Glacial Observation

The glacial erosional environment suggests a dominant earlier flow towards the east (090 ± 15°), with a later overprint revealing a radial flow pattern from the area that may be related to the remnant ice cap in the area first suggested by Grant (1974).

In the depositional environment, it may be noted that there is a general lack of overburden towards the coast and in the northern half of the field area. The thickest deposits are those in the Butts Pond area and around Gambo, both of which are related to downwasting of the ice. The tills across the rest of the area may be described as gray to pink-gray in color, and sandy fossil in texture. Some are overconsolidated.

Future Plans

Analysis of the collected samples for grain-size distribution, geochemistry and lithologies is ongoing. Supplementary data are also currently being investigated. Little data of a final nature can be presented at this time.

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SEDIMENTOLOGY AND BASIN ANALYSIS OF THE CONCEPTION GROUP, AVALON ZONE, NEWFOUNDLAND

by

Scott Gardiner*

Six well exposed stratigraphic sections representing the Mall Bay and Drook Formations of the Precambrian (Hadrynian) Conception Group were studied in the area of St. Mary's Bay, Avalon Peninsula, Newfoundland (Figure 1).

Analysis has led to the identification of six facies (A through F), tentatively interpreted as the products of lobe, interlobe, lobe fringe, fan fringe and basin plain sedimentation within a turbidite fan depositional environment. Minor deposition and reworking of sediment by contour currents is also possible.

Paleocurrent analysis indicated dominant flow toward the northeast with some southerly, southeasterly and southwesterly paleoflow directions. This indicates that the volcanic (and/or granitic) source terrane was nearby, probably to the southwest.

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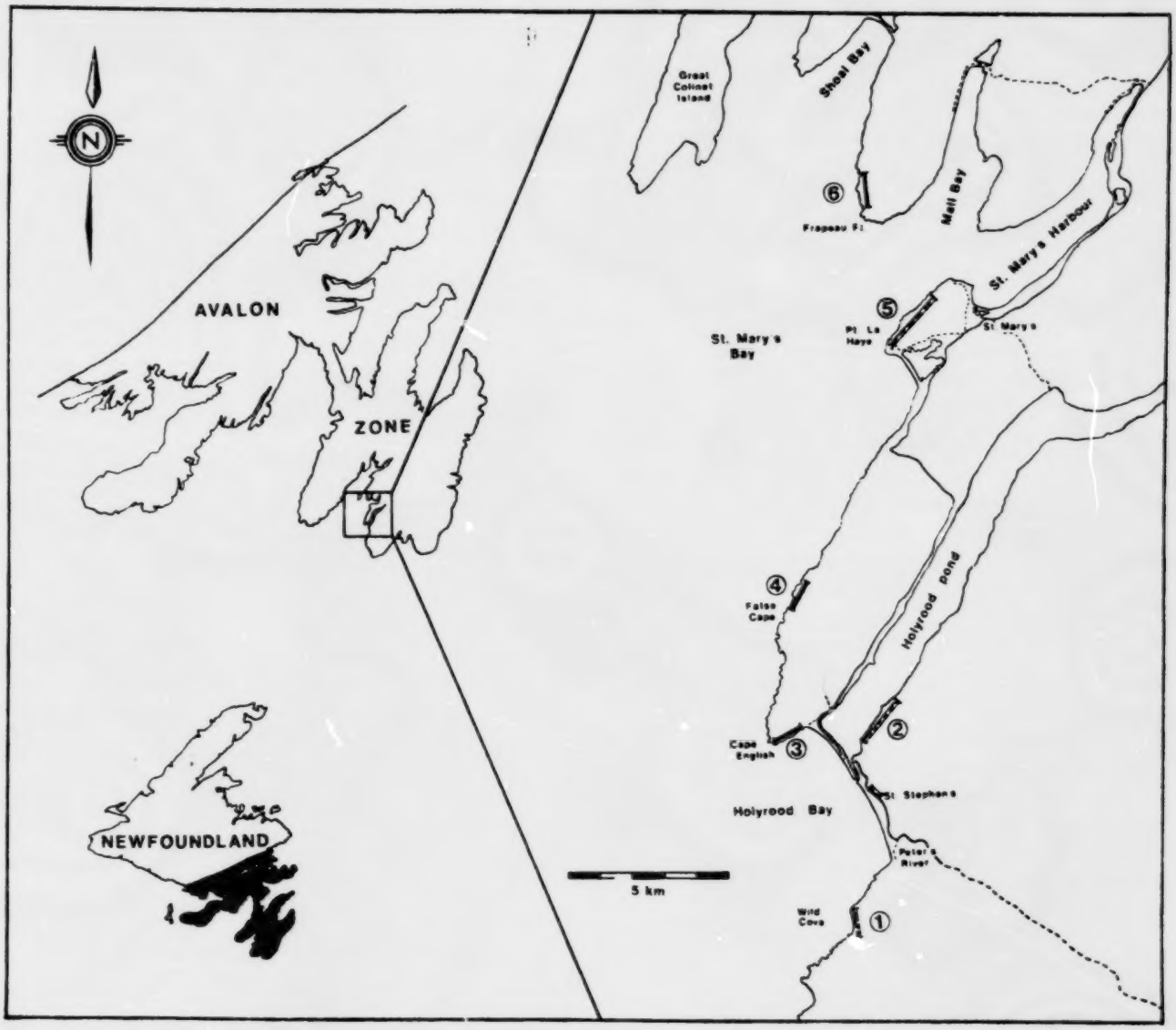

Figure 1: *Location map of outcrops studied.*

General

A NEW PROVISIONAL GEOLOGICAL MAP OF THE ISLAND OF NEWFOUNDLAND

by

James Hibbard*
formerly of the Mineral Deposits Section

ABSTRACT

A new 1:500,000 scale geological map of the island of Newfoundland was compiled during the first half of 1983. The new map will be formally drafted and put on open file during the winter.

The legend of the new map reflects those of its predecessors, yet establishes a new identity. As on an earlier map of Newfoundland, the legend is divided into three major parts corresponding to western, central and eastern Newfoundland. Within each area, however, depositional and plutonic packages have been outlined, a major departure from the scheme of previous maps. The usefulness of the updated map will ultimately be determined by the verity and flexibility of the new, refined legend.

INTRODUCTION

Since Jukes first undertook a geological survey of Newfoundland in 1839, the major objective of the Newfoundland Department of Mines and Energy has remained ".... to know what are the different earthy or mineral masses of which the country is composed, and what are their relative and actual positions." (Jukes, 1842a). A new 1:500,000 scale geological map of the island of Newfoundland, compiled during the first half of 1983, represents the most recent stage in the fulfillment of this objective. A hand-drafted copy of the final map has been prepared, with the intention of producing a blackline open file copy during the winter; the long range prospect for the map may include color production as early as 1985.

The time is ripe for a new geological map of the island; more than fifteen years of intensive geological mapping has been undertaken since the last island-scale map was produced. Most of the new mapping has been undertaken by government surveys. During the 1960's and early 1970's, work was done largely by the Geological Survey of Canada, whereas since the mid-1970's, a revitalized Newfoundland Department of Mines and Energy has developed an extensive 1:50,000 scale mapping program on the island. This program is largely the result of a contract under the auspices of the federal Department of Regional Economic Expansion. In addition, industry and academia have made significant contributions to the new map. Government-financed mapping of the island continues, and so the new map of the island will be progressively updated until color production is started.

HISTORY

The new Newfoundland map is heir to a succession of geological maps of the island that date back to 1842 (Jukes, 1842b). Baird (1954a) summarized more than 100 years of development of Newfoundland mapping when he published a geological map of the island (Baird 1954b); his review included short discussions of a geological map of the island by Howley (circa 1905), a sketch map of the island by Snelgrove (1937),

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and an unpublished map by E.R. Rose (circa 1947), as well as a description of his own, then new, map. The present map is a direct descendant of Williams' 1967 map, which succeeded Baird's contribution.

THE NEW MAP

The new geological map of Newfoundland partly reflects its predecessors, yet has features that give it a distinctive character. Its close relationship to Williams' 1967 map is most apparent in the overall layout of the legend. The legends of both are divided into three major parts, including western, central and eastern Newfoundland. These divisions are based mainly on geography; however, they also reflect, roughly, the major Ordovician and older lithostratigraphic divisions of the island as first intuitively deduced by Williams (1967). The three divisions are linked by mere lithostratigraphic shreds: the western and central areas share anorthosite bodies (along the Cabot Fault) and ophiolitic suites of similar ages, whereas the central and eastern areas are linked by Devonian granite. Carboniferous rocks overlap both the western and central areas and occur in small patches in the eastern area.

The distinctive character of the new map is evident in the division of rock units within each area. The philosophy of the new legend is based on distinguishing major depositional and intrusive packages through time, for each of the three parts of the island. This compilation scheme contrasts with that of the 1967 version, which was based on a "lumping by age" style of legend. The new refinement is possible mainly because of the finer scale of geological maps now available. The finer scale maps have also allowed for major changes in the boundaries between units, especially in southern and central Newfoundland. Stratigraphic nomenclature plays a minor role on the new map, and is keyed to numerical subscripts. For example, in the central area, a major depositional package of mainly basinal clastic rocks includes the Davidsville, Bay d'Espoir, and Baie du Nord Groups; the package is labelled Ocs for Ordovician clastic sedimentary rocks, and the individual groups listed are given numerical subscripts 1, 2 and 3, respectively.

Unfortunately, a reduced version of the new map is not available for inclusion in this report. However, the following is a "bare-bones" summary of the legend. The divisions discussed below have been distilled from the work of numerous geologists; for the sake of brevity, references are not included.

Western Newfoundland

The legend for the western part of the island strongly reflects the well established tectonic history of the area; its divisions record the evolution and destruction of an Early Paleozoic continental margin. The major stratified rock packages (including ophiolites) outlined on the map for this area include the following:

(1) ' a Precambrian infrastructure of mainly undivided gneisses;

(2) an Eocambrian-Cambrian mixed siliciclastic and carbonate sequence that overlies (1), and is in part related to the rift formation of the continental margin;

(3) three divisions of a Cambro-Ordovician carbonate bank (based on age and depositional environment) that were deposited on (2);

(4) a Middle Ordovician flysch sequence that smothers part of (3);

(5) allochthonous Cambro-Ordovician sedimentary, volcanic, ophiolitic igneous, and metamorphic rocks that were derived from an area at the eastern edge of the continental margin;

(6) Middle Ordovician parallochthonous sedimentary rocks that were deposited upon the allochthonous rocks as the latter were emplaced;

(7) Ordovician to Silurian neoautochthonous sedimentary rocks deposited upon the emplaced allochthons, to the east these include felsic volcanic rocks;

(8) deformed and metamorphosed Lower Paleozoic rocks equivalent to those listed above;

(9) Devonian to Carboniferous fluviatile, lacustrine and shallow marine sedimentary rocks.

The major plutonic divisions in the western area include the following:

(1) a variety of Precambrian intrusions in the crystalline infrastructure;

(2) Precambrian to Cambrian diabase dike swarm that intrudes the crystalline infrastructure and lower parts of the mixed siliclastic and carbonate sequence

(3) Silurian to Devonian granitoid rocks along the eastern margin of the area.

Central Newfoundland

As for the western area, the central Newfoundland legend reflects an established tectonic history; the divisions document the evolution of a Lower Paleozoic volcanic arc system and its associated sedimentary basins that were all initiated on oceanic crust. The major stratified units (including ophiolites) include the following:

(1) a Cambrian(?)-Ordovician ophiolitic basement equivalent to allochthonous ophiolites of western Newfoundland;

(2) paragneisses that may be related to Precambrian rocks of the western part of the island;

(3) Lower Ordovician "early" volcanic arc sequence with associated sedimentary rocks;

(4) a southeastern basinal clastic facies that appears to be coeval with the "early" arc,

(5) a distinct Middle Ordovician black shale and siliceous argillite unit;

(6) an Upper Ordovician to Devonian "late" volcanic arc sequence with associated sedimentary rocks;

(7) a sequence of apparently Ordovician quartz-rich clastic rocks that may be derived from either more silicic parts of the "early" arc or from an as yet undiscovered continental source;

(8) undivided, mainly metamorphic rocks that may, in large part, be equivalent to facies listed above;

(9) Devonian to Carboniferous fluviatile and lacustrine sedimentary rocks.

The plutonic divisions used for the central area of the new map are not fully established, but relate in large part to the tectonics of the volcanic arc. The following divisions are tentative, because diagnostic data used in separating intrusions is generally of an analytical nature, such as radiometric dating, petrochemistry, and isotopic ratios, and because work has been carried out only on a cursory regional scale. The plutonic divisions are as follows:

(1) Precambrian anorthosite and possible Precambrian granitoid rock, probably related to similar age rocks of western Newfoundland;

(2) Ordovician granitoid rocks, including extensive areas of tonalitic to granodioritic rocks

(3) Ordovician to Silurian granitoids and minor related mafic phases;

(4) a variety of divisions of Ordovician to Carboniferous granitoids and mafic intrusions that are separated on the basis ofmineralogy, petrochemistry, physical features, and age constraints;

(5) Jurassic, mainly mafic stocks.

Eastern Newfoundland

The eastern Newfoundland legend is composed of well established depositional and plutonic packages, however, the unified tectonic theme of the belt is not totally clear. In recent years, the rocks of the area have been thought to represent an episode of Early Hadrynian rifting with subsequent abortion. foundering and infilling of the rift basin. The major stratified divisions of the new map include the following:

(1) Early to Middle Hadrynian mafic volcanic rocks and associated sedimentary rocks;

(2) Hadrynian basinal sedimentary sequences, one of which includes a distinctive mixtite unit;

(3) Late Hadrynian bimodal volcanic sequences;

(4) Late Hadrynian shallow marine to fluviatile sequences;

(5) Eocambrian to Lower Ordovician shallow marine clastic and carbonate rocks;

(6) Devonian to Carboniferous alluvial, fluvial, and lacustrine clastic rocks and mainly felsic, subaerial volcanic rocks.

Plutonic divisions of the eastern area include the following:

(1) Early to Middle Hadrynian gabbro to granodiorite, probably related to equivalent age volcanic rocks;

(2) Hadrynian granitoid and mafic rocks probably related to the bimodal volcanic division;

(3) Cambrian(?) diabase and gabbro;

(4) undivided mafic and granitoid rocks of uncertain age;

(5) Devonian granitoid and related mafic rocks;

(6) Carboniferous peralkaline granite.

POTENTIAL USES OF THE MAP

A map of the island at 1:500,000 scale has a myriad of uses in government, industry and academia, ranging from a base map for pinpointing potential mineral exploration target areas, to an "ideas" map for engendering new ideas on such concepts as orogenesis. The map is already earmarked to be modified for use as a base for a new metallogenic map of the island; in a similar vein, it could form a base for topical overlays depicting such themes as radiometric age data, isotope data, fossil locations and provinciality, metamorphism and timing of deformation. Use of the map is not limited to geosciences, but may be helpful to such fields as forestry and agriculture.

The ultimate success of the map depends upon the objectivity, verity, and flexibility of the legend. My feelings about the map are best expressed in a quotation with which Baird (1954a) also ended his report on the 1954 geological map:

"With regard to the distribution of the geological formations, it will be clear to anyone at all conversant

the difficulties attendant upon drawing in boundary lines with accuracy, especially in wild unknown or unfrequented regions, that many alterations and modifications will hereafter be necessary before the map can be considered by any means complete; nevertheless, I feel tolerably sure that the approximation is such as to be of considerable service for present purposes, and wibe a useful guide for future and more minute investigation of details."

Alexander Murray (1881)

ACKNOWLEDGEMENTS

I appreciate the efforts of all those who contributed information during compilation of the map; you are all listed on the map. I thank Paul Dean and Hank Williams for review and constructive criticism of the legend, Ken Byrne for procuring the base map and his continued help with map reduction, and Jane Murray for editing the legend. Special thanks go to Bryan Greene and Paul Dean for giving me the opportunity to carry out this project.

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POSTSCRIPT

During the months of compilation work on the new map, the following observations on the geology of the island struck me as intriguing and significant enough to pass on as fodder for friendly argument if not as bases for new thought:

(1) Tonalitic to granodioritic gneisses and migmatites of apparently similar age appear to cradle the central area on three sides. These units include the informal Southwest Brook Complex and southwesterly equivalents, the Cinq Cerf Complex, tonalitic migmatite at Grey River, tonalitic rocks of the Little Passage gneisses and the Hare Bay gneiss. These rocks appear to be of Lower Ordovician age. Their similar composition and apparent age prompts me to invoke the interpretation that a similar process acted in their formation. The process could well be partial melting of mafic rocks above a single subduction zone, a zone that once stretched beneath the entire central belt.

(2) Quartz-rich clastic rocks occur along strike from felsic volcanic rocks of the La Poile Group in southwestern Newfoundland. These rocks rocks appear to be equivalent to similar rocks of the Gander Group; thus, the Gander Group may be derived from a silicic volcanic source rather than the traditionally supposed continental source. Although a large volume of silicic volcanic rocks is not evident immediately adjacent to the Gander Group, the durable quartz constituents of the clastics may have been transported and deposited in a basin somewhat remote from the source.

(3) The Baie Verte Flexure has been interpreted as representing the original morphology of the ancient North American continent. Intriguingly, Eocambrian dikes related to rifting and formation of Iapetus trend south, through Grenville gneisses of the northern Long Range Mountains, as far as the latitude of the flexure, where they appear to deflect westward. This would infer a flexure in the ancient margin in this area. Coincidentally, at the same latitude and slightly to the west, the north striking Cow Head rocks are autochthonous rather than allochthonous, as previously thought (R.K. Stevens and S. Stouge, personal communication, 1983). They base their evidence on the state of preservation of conodonts in the Cow Head sequence. Thus the breccias may not have been deposited on a continental slope to the east and transported west during Taconic orogenesis; rather they may have been deposited on a slope at a westerly embayment in the margin and are virtually in situ.

MINERAL POTENTIAL OF CLASTIC SEDIMENTARY BASINS IN NEWFOUNDLAND

by

P.L. Dean and J.R. Meyer
Mineral Deposits Section

A continuation of the evaluation of the mineral potential of clastic sedimentary basins in Newfoundland was conducted during the summer of 1983 (Figure 1). Four open file reports on the work carried out in the previous two summers were completed last spring and released in July. The first three were "Stream Sediment Geochemistry of Three Sedimentary Sequences in Insular Newfoundland", Open File Releases 1K (19), 1N (440) and NFLD. (1316). The fourth was "Lithogeochemistry of Middle Ordovician Chert and Shale of Central Newfoundland", Open File Release NFLD. (1317). During the 1983 field season, follow-up work on two of the stream sediment geochemistry releases was carried out; the Avalon South release, 1K (19), and the Humber Arm North release, NFLD. (1316). Mineralization coincident with the indicated anomalies was discovered in the former. Follow-up of the Middle Ordovician Chert and Shale release uncovered visible base metal sulfides for several base metal/barium anomalies, and fluorapatite nodules for a phosphate anomaly. More detailed work on rock samples collected may identify the mineral phase containing the barium, which is present in amounts up to 2%. The shale lithogeochemistry program was expanded to cover the potassium-rich Cambrian "Forteau Shales" on the Northern Peninsula, and the Cambro-Ordovician shales of Random Island and adjacent areas. Lake sediment base metal anomalies on the western side of the Baie Verte Peninsula were also followed up and many new mineral showings were discovered, all coinciding extremely well with the geochemical anomalies.

Open File Release

Four open file reports were released during the summer. Results from the 1982 stream sediment geochemistry program (Dean and Meyer, 1983) constituted three releases, two from the Avalon Peninsula (Avalon South - 1K (19) and Avalon North - 1N (440)) and one from the west coast (Humber Arm North - Nfld. (1310)), east of the Bay of Islands. Analyses released for each area include 8 or 9 single element maps (Zn, Pb, Ni, Cu, Co, Cd, Fe, Mn, ± Ag and F), a loss-on-ignition map, 4 or 5 residual maps (single element regressions with Fe, Mn, and/or L.O.I.), and sample location maps. Brief reports outlining the geology of the areas and the methods of analysis accompany each release. The Avalon North area was actively explored during the 1983 field season by private industry.

The fourth open file release (Nfld. (1317)) contains results from a lithogeochemical study of Middle Ordovician chert and shale from central Newfoundland (Dean and Meyer. 1982). Twenty-four sections had been mapped and sampled in detail and 995 samples were analyzed for 24 major and minor elements. The analytical results, accompanied by statistical analyses and field data, are contained in a computer print-

Contribution to the Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Newfoundland Department of Mines and Energy and the Geological Survey of Canada.

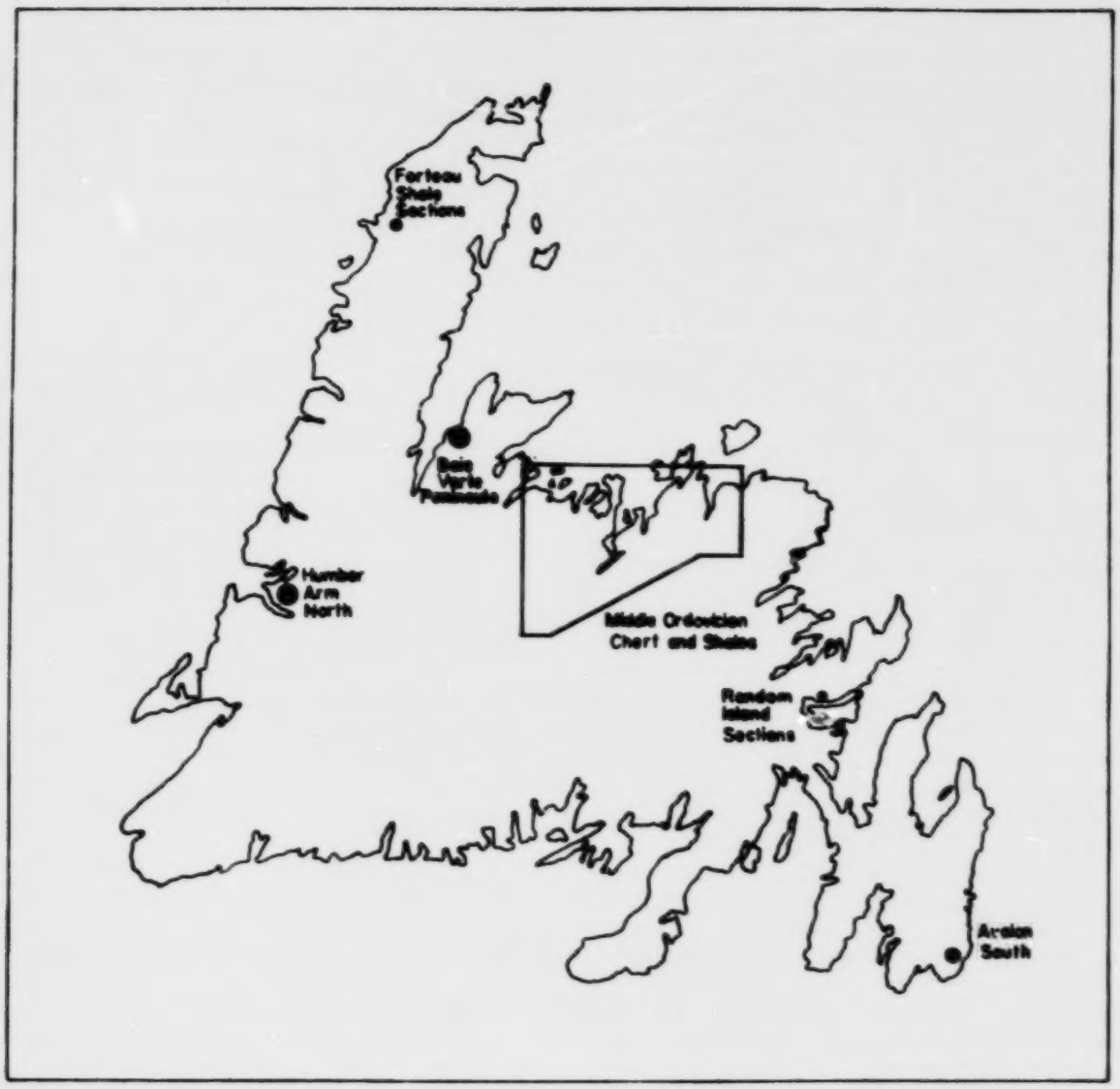

Fig.1 Mineral Potential of Clastic Sedimentary Basins in Insular Newfoundland - 1983 Field Areas

out. Detailed stratigraphic sections and location maps are included for each sampled area.

Avalon South

The results of last summer's stream sampling (Dean and Meyer, 1983) confirmed the Zn/Pb/Co lake sediment anomalies (Davenport et al., 1975; Butler and Davenport, 1979) in the Chance Cove and Portugal Cove Brook areas. Coincident Cu, Cd and Ni anomalies are also present. Concentrated prospecting of the bedrock and *in situ* float uncovered visible sulfide mineralization in close proximity to several of the anomalies. The style of mineralization was extremely similar to that seen in the northern Avalon, west of Carbonear (Dean and Meyer, 1983, page 146). Chalcopyrite. sphalerite and galena were found as isolated blebs in medium to coarse grained sandstone of the Hadrynian Drook Formation, often associated with 1 to 5 mm black weathered pyrrhotite blebs. Oval shaped pyrrhotite/magnetite "eyes" (2 to 5 mm long) were observed in finer grained siltstone, and these may contain minor base metals. New lithologic observations within the Drook Formation include boulders of volcano-sedimentary breccias and tuffaceous rocks that form a rough trend 2 km northwest of Route 10 and semi-paralleling the highway. There is a Ag/Pb/Ni/Cu anomaly in the vicinity of the tuffaceous rocks.

Humber Arm North

The stream sediment geochemistry from this area (Open File Nfld. (1316)) shows localized base metal highs with few real trends and no noticeable groupings or combinations of elements. The Pb highs originally found in the lake sediment geochemistry (Butler and Davenport, 1980) are largely supported by the stream sediment results, but do not show preference for underlying lithologies or formations. Numerous Cu anomalies show a small preference for the red slates and shales of the Upper Summerside Formation. The only mineralization found during this follow-up were thin laminations of pyrite hosted by black shales of the Irishtown Formation, and minor malachite in sandstone.

Middle Ordovician Cherts and Shale of Central Newfoundland

The computer printout and statistical analyses from Open File Nfld. (1317) indicate base metal anomalies and other unusual highs (i.e. Ba, P, Mn, etc.) from Middle Ordovician chert and shale sections sampled in 1981 (Dean and Meyer, 1982). Galena was observed in 1 to 2 cm thick Mn-carbonate bands and along fracture planes in the lower intervals of the Luscombe Point Section at Loon Bay. The adjacent Loon Bay road section hosts the most impressive Pb. Zn, Cu, Ni and Ag anomalies (individual elements, and in association), but only isolated blebs of chalcopyrite have been observed. Barium is present in amounts up to 2%, but the presence of barium minerals is not readily apparent. The Loon Bay section has total iron concentrations of up to 20% in several intervals which display massive, well banded pyrrhotite and pyrite mineralization.

Nodules sampled from the black chert and shale at Lawrence Harbour South contain 26% P_2O_5, 34% CaO, 25% SiO_2, and 22,110 g/t fluorine. These are dense, black nodules and contain very thin (<1 mm) quartz veins. They vary in shape and size from small rounded nodules 3 cm by 5 cm, to large elongate lenses 15 cm by 40 cm. (The latter have not yet been analyzed.) These are thought to be fluorapatite nodules and they occur in 6 intervals at the Lawrence Harbour South section, and 3 intervals at the Red Cliff section.

Northern Peninsula

Reconnaissance sampling of the Cambrian Forteau shales on the Northern peninsula indicate a high K_2O content (R. Stevens, personal communication, 1977 and 1983). These shales are readily exposed in road quarries along the

western portion of the Roddickton road (Route #432) and immediately to the south at Three Mile Pond. Four relatively undeformed sections were chip sampled in 3 m intervals. The shales, which typically weather rusty brown, are dark gray, medium to thickly laminated and very friable. They are generally very calcareous, rarely manganiferous and contain trilobite imprints, pyrite nodules and beds rich in limestone nodules. A fine to coarse grained clastic limestone unit usually overlies these shales.

Random Island

Two representative sections of Cambro-Ordovician shale (and slate), sandstone and limestone were sampled in the Random Island area on the west side of Trinity Bay. A 2.5 km coastal exposure at Smith Point contains an excellent section of the Lower to Middle Cambrian Adeytown Group, which disconformably overlies the Random Formation near White Rock (Jenness, 1963). It consists of dominantly green to brownish red slaty shale with limestone concretions, and interbedded thin to thick, pink, green and gray limestone beds, some of which exhibit very resistant algal structures. There are several thin silty horizons, a 6 m thickly bedded sandstone interval, and a single 1 m thick, extremely dense manganiferous zone. Dark gray and black shale at the base of the conformably overlying Harcourt Group was sampled at the top of this section in Broad Cove.

A more complete section of the Harcourt Group was sampled on the south side of Random Island, between Fosters Point and Elliot's Cove A change from red and green to gray and black shales approximately 0.75 km north of Fosters Point marks the base of the Harcourt Group. The southern half of the section consists of steeply dipping, undeformed gray to black shale and slaty shale with minor siltstone, sandstone and limestone. The shale typically weathers rusty brown, appears sulfur-rich, is very friable and contains calcareous concretions 5 to 30 cm in diameter. Two porphyritic dikes 10 and 50 cm thick were observed and contain minor pyrite. The northern half of the section consists of strongly deformed black and gray graphitic shale with thin sandstone interbeds and calcareous concretions. Each of the lithologies above was sampled in at least one location. Additional samples of the Harcourt Group were collected from the shale quarries operated by Trinity Brick Ltd. at the northwest end of Random Island.

Baie Verte Peninsula

Base metal anomalies are indicated by lake sediment geochemistry (Open File 12H (734) - Sandy Lake map sheet) on the western side of the Baie Verte Peninsula (Figure 2). A north trending series of copper anomalies which parallel lithologic trends are present in the Westport area, and localized Zn/Cu and Zn/Pb anomalies exist between Baie Verte and Seal Cove. The area is underlain by strongly metamorphosed rocks of the Eocambrian to Middle Ordovician White Bay and Old House Cove Groups. These rocks consist of dominantly northeast striking psammite and pelite with lesser marble, mafic and graphitic schist and amphibolite. The psammite in the Westport area contains very minor pyrite, but about 12 km to the northeast, quartzose bands in a garnetiferous psammite are host to chalcopyrite and pyrite mineralization on the west side of East Pond (which has coincident Cu/Ag highs in its lake sediment geochemistry). Graphitic schists exposed in roadcuts halfway between Westport and Western Arm contain up to 4% pyrite/pyrrhotite mineralization. The 'amphibolite' units, interpreted as dikes, sills and flows, intrude and are part of the Old House Cove Group and older rocks in the area. They are dark green, usually porphyroblastic, and frequently host chalcopyrite mineralization (2% in grab samples). These units occur adjacent to ponds with anomalously high copper values in their lake sediments. Vuggy

boulders of 'amphibolite' are host to veinlets of ruby red, glassy to resinous sphalerite and disseminated chalcopyrite in the Osbournes Pond area. The veinlets are 1 to 10 mm thick, up to 10 cm long, and often intimately associated with calcite and quartz veins. Other 'amphibolite' boulders found on the shores of this pond contain up to 1 to 2% combined chalcopyrite/pyrrhotite. A road quarry 2 km west of Osbournes Pond contains quartz/carbonate veins which host galena, sphalerite, molybdenite and pyrite mineralization. Rusty weathering pelites 1.5 km east of this same pond contain up to 5% chalcopyrite, pyrrhotite and pyrite mineralization. All the mineralization found in this area coincides remarkable well with the lake sediment geochemistry.

Conclusion

The evaluation of clastic sedimentary basins in Newfoundland has been largely based on a geochemical approach. Lake sediment geochemistry has identified at least four areas with base metal anomalies, which are underlain by sedimentary rocks. One of the areas is being actively explored by private industry, while our own prospecting and stream sampling in two of the other areas has confirmed the original anomalies and found many new mineral showings. During the 1983 field season, bedrock mineralization was discovered in most areas with geochemical anomalies.

The lithogeochemical study of central Newfoundland chert and shale has confirmed the existence of metal-rich, fine grained sedimentary rocks. Variations in the concentration of elements, such as Ba, by amounts of 200 to 20,000 g/t suggest introduction, migration and/or concentration by fluids favorable to ore deposition. Clearly, there is scope for further exploration for clastic-hosted base metal sulfide deposits in Newfoundland.

Acknowledgements

We would like to thank Terry Brace a hard working senior assistant; Angela best, tor inspiration and energy on the way to work each morning, and Hanny Muggeridge for volunteering her summer and very keen eyes.

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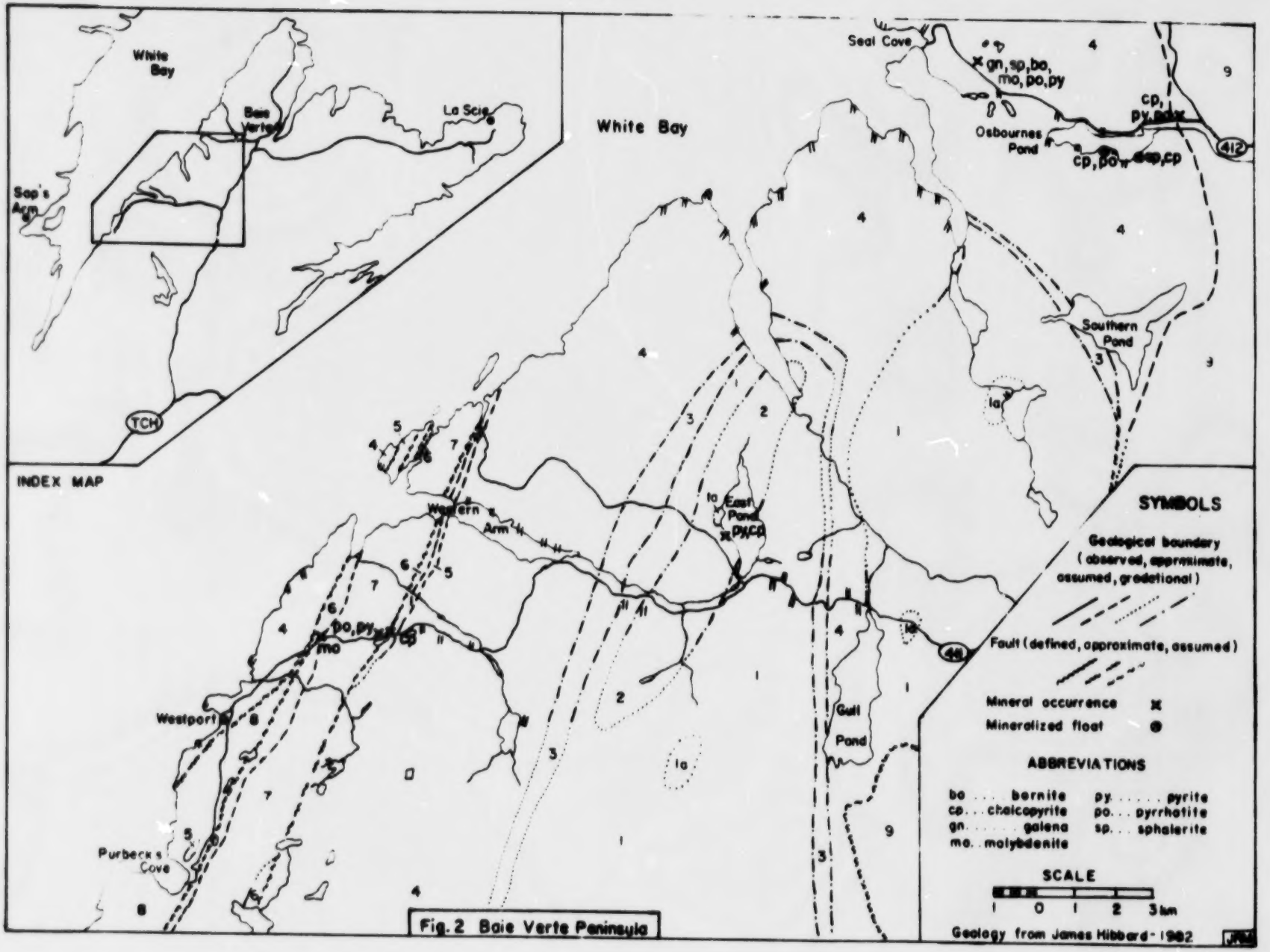

Fig. 2 Baie Verte Peninsula

LEGEND (Figure 2)

MIDDLE ORDOVICIAN TO HADRYNIAN

Rattling Brook Group

9 Unseparated semipelitic, pelitic and psammitic schist; minor greenschist, marble and graphitic schist.

White Bay Group (Units 5-8)

8 Unseparated semipelitic, pelitic, and graphitic schist with subordinate psammitic garnet porphyroblastic, and mafic schist; minor marble and quartz-pebble metaconglomerate

7 **Pigeon Island Formation**: Mainly garnet porphyroblastic quartz-muscovite semipelitic schist, feldspathic psammitic schist, locally magnetite-rich and graphitic schist.

6 **Garden Cove Formation**: Medium to dark green amphibolite and mafic schist locally fragmental.

5 Mainly marble and carbonate schist, local marble breccia and conglomerate; minor quartzite.

Old House Cove Group (Units 3 and 4)

4 Buff to gray weathering, medium to coarse grained psammitic and semipelitic schist minor pebbly psammitic schist and graphitic schist.

5 Medium to coarse grained feldspar porphyroblastic mica schist, tectonically derived from Units 1 and 4.

HADRYNIAN AND EARLIER (?)

East Pond Metamorphic Suite (Units 1 and 2)

2 **Middle Arm Metaconglomerate**: Mainly polymictic metaconglomerate with interlayed buff to gray psammitic schist.

1 Dominantly fine to medium grained gray psammitic and semipelitic schist and gneiss, may include rocks equivalent to Unit 4; **1a**, migmatite gneiss and gray banded quartzofeldspathic gneiss, minor pink granitic gneiss.

// Mainly massive, blackish green amphibolite dikes, sills, and pods, locally eclogitic in Units 1 and 2.

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DETAILED AGGREGATE ASSESSMENT PROJECT - INSULAR NEWFOUNDLAND

by

F.T. Kirby
Environmental Geology Section

Introduction

This year was the second year (Kirby, 1983) of the detailed Aggregate Resources Mapping in Insular Newfoundland. In the years before the start of this project in 1982, some detailed assessments were carried out under the Inventory of Aggregate Resources Program. These areas included Butts Pond (1979), Sandy Brook - Grand Falls (1979), and Gros Morne National Park (1981); a start had been made on the St. John's Urban Region Plan Area (1981). During the 1982 field program, aggregate resource assessments were done in 13 municipal planning areas throughout insular Newfoundland (Map 1).

Objectives of Program

The main aim of the project is to identify areas of quality aggregate resources within municipal or other areas where the implementation of land use zoning might sterilize (remove from future production) areas of aggregate resources. The process involves locating and sampling in detail any aggregate reserves within the proposed development or plan areas. In areas lacking quality aggregates (*i.e.* gravels and sands), alternative sources such as silt/clay-free till and/or suitable bedrock are assessed in regards to current and future needs. The designation of the aggregate resources as extraction areas within specific planning proposals (e.g. municipal plans) is proposed to ensure that the aggregates can be preserved to meet the future aggregate demand in these areas. This likewise ensures that the local domestic and commercial aggregate consumer has access to material at a reasonable cost.

Field Program, 1983

Field work was started in early June and ended in late October. Municipal planning areas included St. Anthony, Sops Arm, Jacksons Arm, Baie Verte, Gander, Carmanville, Marystown and St. Lawrence. Backhoe test pitting conducted in the St. John's Urban Region Planning area (Map 11), in October completed field work on that plan area.

Approximately 350 aggregate and rock samples were collected in 1983. All aggregate samples collected were field sieved using a bank of four 30 mm diameter brass sieves (63 mm, 31.5 mm, 16 mm, 8 mm). Sample fractions retained on each sieve were weighed and the weights recorded. A 500 g split of the sample passing the 8 mm sieve was retained for further laboratory sieve analysis. A split of the plus 16 mm, minus 32 mm pebble fraction was retained for lithologic and petrographic number analyses.

Preliminary field mapping in each area was conducted at 1:50,000 scale to supplement previous aggregate resource data (Kirby et al., 1983). Detailed sampling and backhoe test pitting were normally conducted at 1:12,500 scale using orthophotos or enlargements of 1:50,000 scale topographic mapping. When available, larger scale municipal plans

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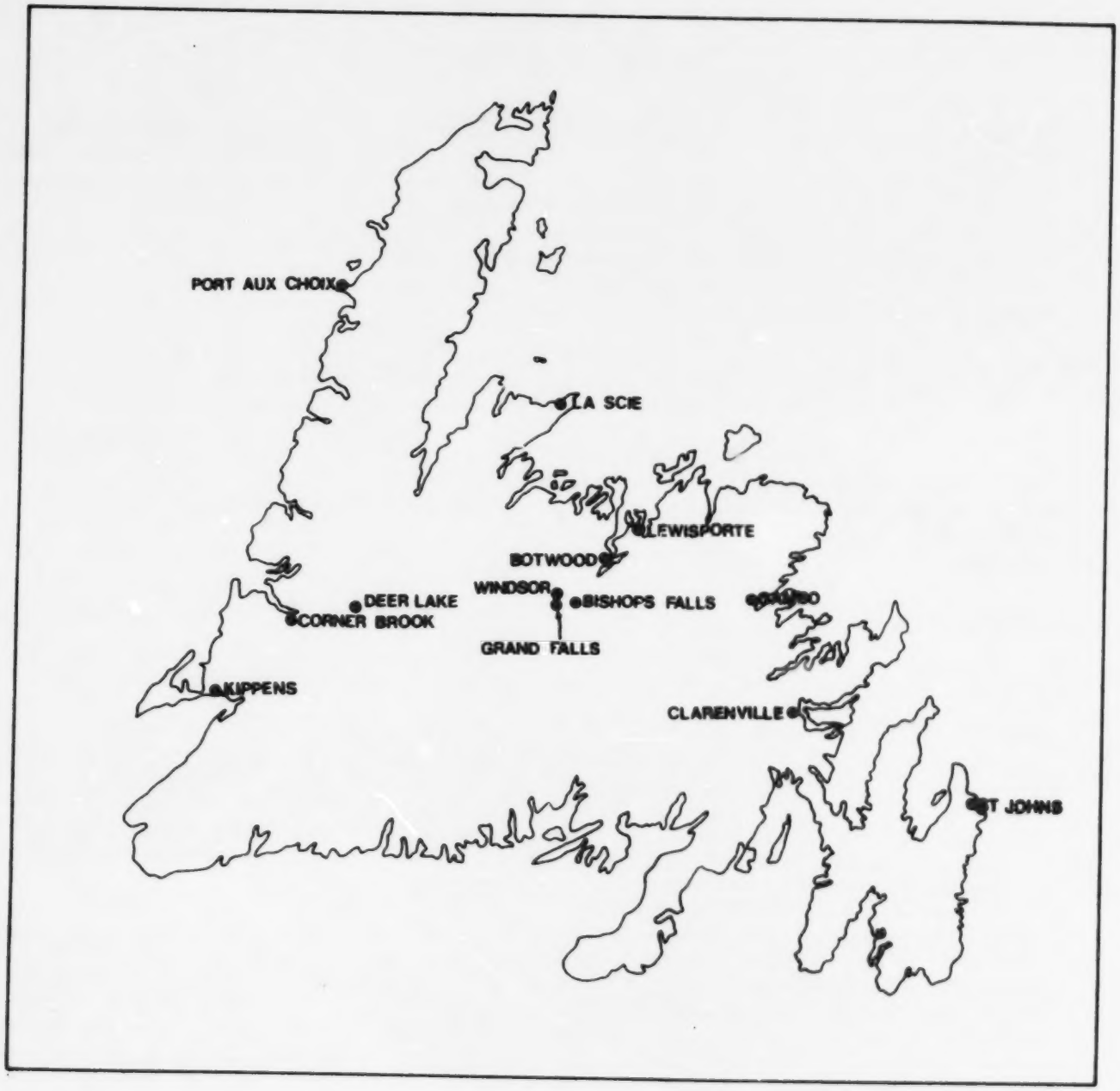
Project funded by the Newfoundland Department of Mines and Energy.



Map I: *Detailed aggregate resources project, insular Newfoundland field areas, 1982.*

Map II: ***Detailed aggregate resources project, insular Newfoundland field areas, 1983.***

(supplied by the Department of Municipal Affairs) were utilized.

Fall/Winter Program, 1983

During the late fall of 1983, a series of 1:50,000 and 1:12,500 scale maps outlining the areas of aggregate potential for each area studied will be compiled. These maps will be forwarded to the Department of Municipal Affairs for inclusion into their Municipal Plans.

During the winter of 1983-84, maps and sample analyses with accompanying reports will be compiled for open file release.

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REGIONAL GEOCHEMISTRY AND REGIONAL GEOPHYSICS, NEWFOUNDLAND AND LABRADOR

Introduction

As part of the Canada-Newfoundland Cooperative Minerals Program, the Resource Geophysics and Geochemistry Division of the Geological Survey of Canada is conducting regional geochemical and geophysical surveys in Newfoundland and Labrador. Progress to date is described below.

Geochemistry

A two-year program of National Geochemical Reconnaissance Surveys is underway in western and central Labrador (Figure 1). These surveys are under the direction of E.H.W. Hornbrook.

Lake water and center lake bottom sediment samples were collected at an average density of one site per 13 km^2. The lake waters are being analyzed for U, F and pH, and the lake sediments for Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe, Cd, As, Mo, V, Hg, L.O.I. (loss on ignition), U and F. The results from western Labrador were released on August 21, 1983 as four separate open files (see Fig. 1): 13E(41) [G.S.C. open file 901], Lab(613) [G.S.C. open file 902], Lab(614) [G.S.C. open file 903], and Lab(615) [G.S.C. open file 904]. Each open file comprises 19 single element maps, an L.O.I. distribution map, and a map showing sample locations, all plotted at 1:250,000 scale with a geologic base, together with a set of explanatory notes, summary statistics and a complete data listing. The open files are also available on microfiche. Two of these open files (Lab 614 and 615) [G.S.C. 903 and 904] are compilations of data from samples collected in 1982 and 1978 and replace open file Lab (169) [G.S.C. open file 560].

The results from samples collected in 1983 will be released in the summer of 1984. The areas sampled are shown in Figure 1.

Geophysics

Regional geophysical studies under the co-operative program include airborne gamma-ray spectrometric surveys in both Newfoundland and Labrador, and airborne gradiometer surveys in central Newfoundland.

Airborne gamma-ray spectrometric surveys are being carried out in southern Newfoundland (Figure 2) and northern Labrador (Figure 3) under the direction of K.A. Richardson. Both are primarily to aid in mineral exploration in granitoid terrains. The surveys were flown at 1 km line spacing at a mean terrain clearance of 123 m at 190 km/hour. The results from the southern Newfoundland area were released in July, 1983, as a series of nine Geophysical Series Maps as open file Nfld (1318). The individual map areas and the corresponding G.S.C. open file numbers are as follows:

Map sheet	G.S.C. Geophysical Series Map No.
11P/9, part of 1M/12	36611 (9) G
11P/10	36611 (10) G
11P/11	36611 (11) G
11P/14	36611 (14) G
11P/15	36611 (15) G
11P/16, part of 1M/13	36611 (16) G
12A/1, part of 2D/4	35112 (1) G
12A/2	35112 (2) G
12A/3	35112 (3) G

For each NTS area (Figure 2), contour maps of total count, K, eU, eTh, eU/eTh ratio, eU/K ratio and eTh/K ratio

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Project funded by the Geological Survey of Canada

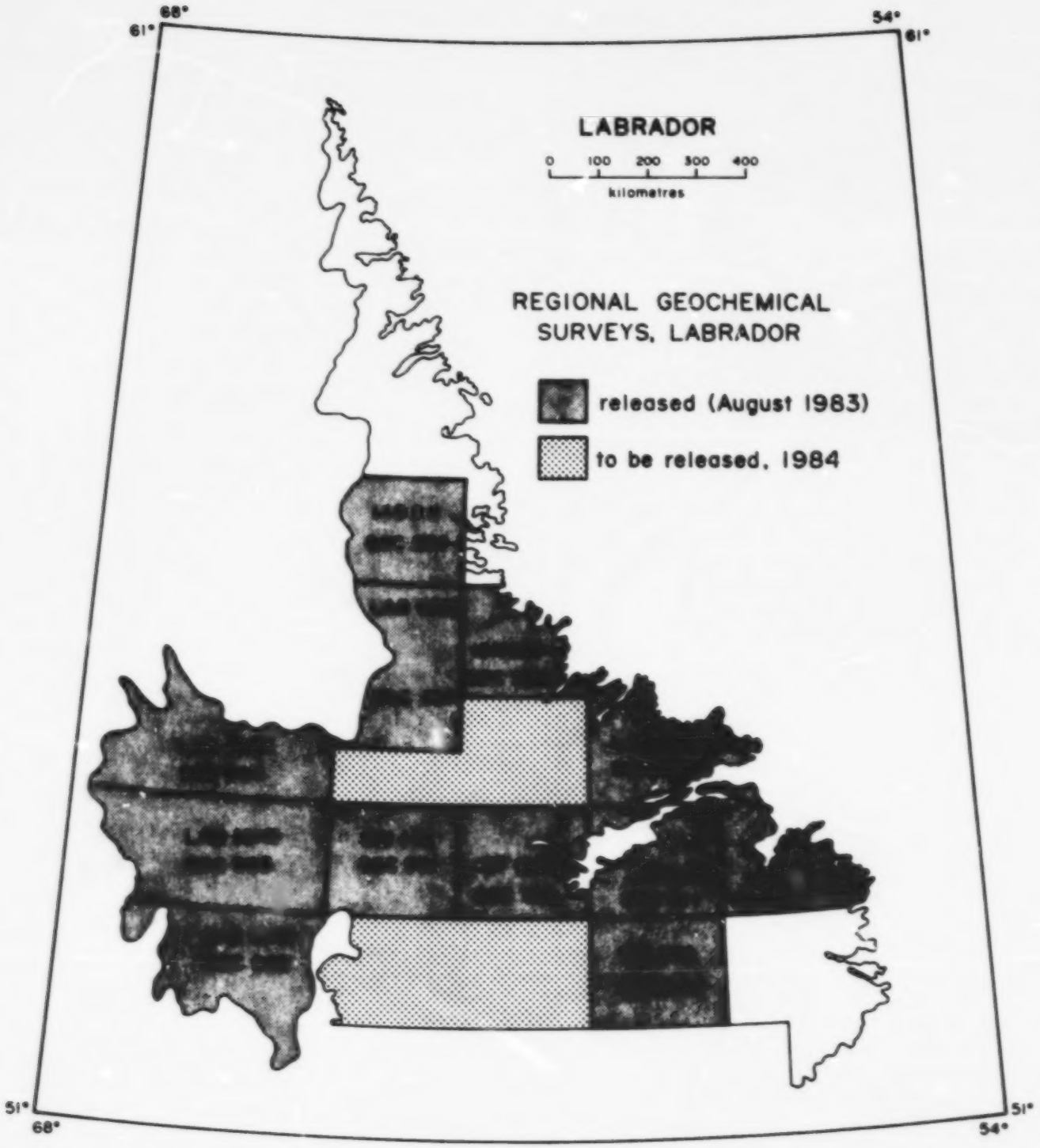

Figure 1: *Coverage of National Geochemical Reconnaissance lake sediment and water surveys in Labrador.*

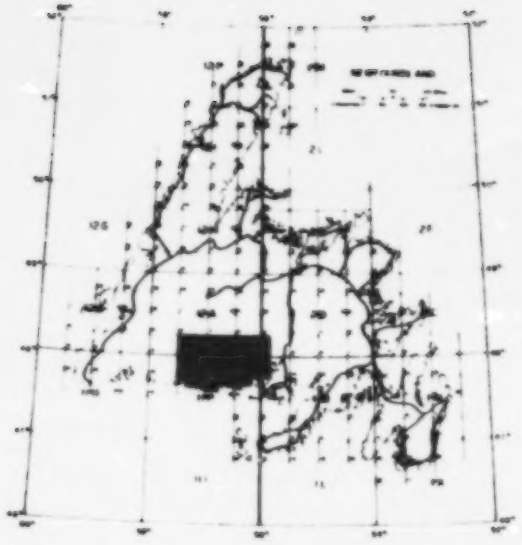

Figure 2: *Location of airborne gamma-ray spectrometric survey in Newfoundland carried out by the Geological Survey of Canada under the Canada-Newfoundland Cooperative Minerals Program.*

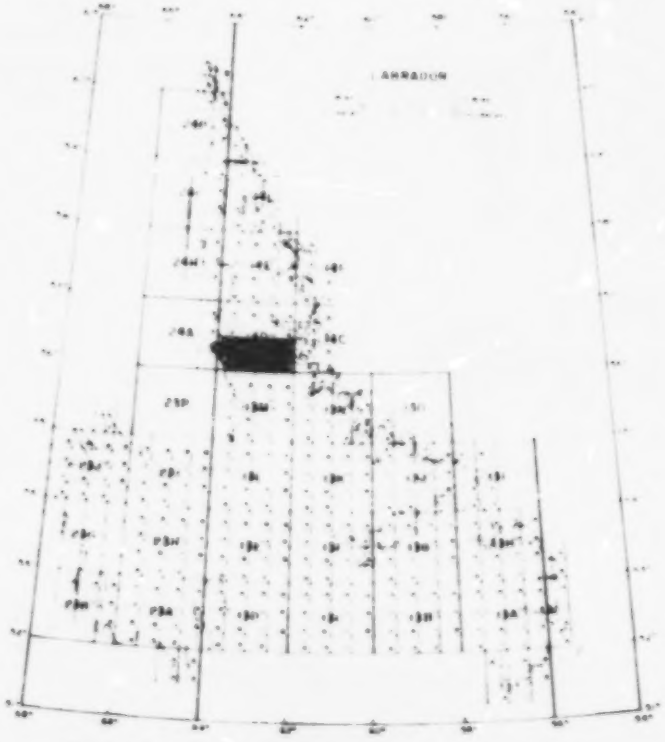

Figure 3: *Location of airborne gamma-ray spectrometric survey in Labrador carried out by the Geological Survey of Canada under the Canada-Newfoundland Cooperative Minerals Program.*

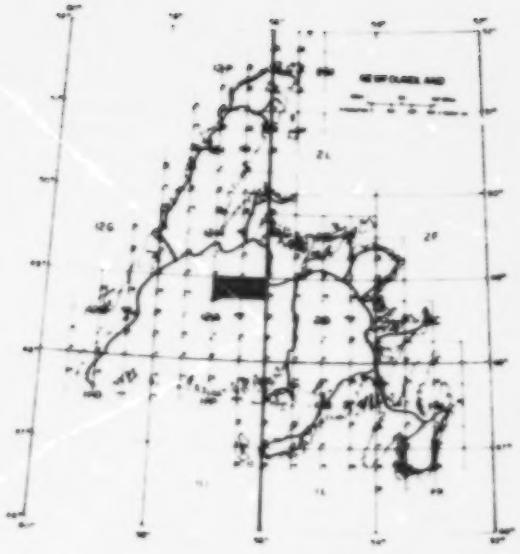

Figure 4: *Location of airborne gradiometer survey in central Newfoundland carried out by the Geological Survey of Canada under the Canada-Newfoundland Cooperative Minerals Program.*

are available at 1:50,000 scale, together with stacked profiles of these seven parameters for all flight lines at 1:100,000.

The Labrador area (Figure 3) was flown in August, 1983, and results are anticipated in the summer of 1984. Although not part of the co-operative program, the release in September, 1983, of the results of an airborne gamma-ray spectrometric survey (Geological Survey of Canada, 1983) immediately west of this area (parts of 24A/1 and 24A/8) is worth noting, as the survey covers the Strange Lake Nb-Ta-Y-Be-Zr-REE deposit discovered by the Iron Ore Company of Canada.

Gradiometer surveys were flown over two 1:50,000 map sheets (12A/15 and 12A/16) in central Newfoundland (Figure 4). These surveys, which are under the direction of P.J. Hood, are intended to map economically important volcanic marker horizons in areas of rather heavy drift cover. The surveys were flown at an altitude of 150 m with a flight-line spacing of 300 m. The results will be compiled as eight sets of maps at 1:25,000 scale, each set consisting of a vertical gradient map, a total magnetic field map and a VLF map.

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AGGREGATE RESOURCES INVENTORY SYSTEM

by

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Environmental Geology Section

Introduction

The Environmental Geology Section has been collecting aggregate resource data throughout the Province since 1975. To this time, approximately 10,000 samples have been collected. The database management system selected for the manipulation of the data is the Scientific Information Retrieval (SIR) system. The end product is the Aggregate Resources Inventory System, an interactive database designed for the storage and retrieval of aggregate and surficial geology data generated by the Section. This report is a brief, nontechnical description of the system as well as the type of data the system holds.

The system consists of a series of programs which permit the user to:

- edit raw data collected by the geologists
- correct any data which was coded incorrecly or omitted
- produce cumulative curve plots of gravel, sand, silt-clay percentages for individual samples
- produce various reports on paper or microfiche, e.g. master-file report, lithological analysis report, particle-size-analysis report
- add, change or delete any data in the database
- unload the database from disk to tape
- reload the database from tape to disk
- check the integrity of the database for any changes since the last time it was accessed

The data in the database can be roughly divided into two categories, information pertinent to a specific sample site or location, and information related to individual samples taken at the site. Of the sixteen record types defined for the database, records 1-6 hold site information and records 7-16 hold information related to a particular sample. This set-up gives the database a hierarchical structure, i.e. each site record has many sample records associated with it.

The record types which pertain to a specific site hold such information as:

- general location of the site
- the landform associated with the site
- any ice movement indicators found at the site
- a list of any photographs taken
- general comments by a geologist concerning the site

The records which hold sample information report on:

- a field description of the sample
- field sieve analysis data
- pebble analysis data
- lithology data from the pebbles in the sample
- laboratory sieve analysis data
- general comments relating to the sample

Data are continually being added to the database with emphasis being placed on entering data collected from 1980-1982. As of August 31, 1983, the

Project financed by the Newfoundland Department of Mines and Energy.

database held information on approximately 4000 sites, with a total of approximately 20,000 records on file. These data were collected primarily from Insular Newfoundland; Labrador data were collected in 1983 and before 1980 and are not in the system. The 1983 data from the entire Province will be input to the database as soon as possible.

THE DEVELOPMENT OF MICRO-COMPUTER PROGRAMS FOR USE BY GEOSCIENTISTS IN THE MINERAL DEVELOPMENT DIVISION

by
H. Missan
Computer Unit

The Mineral Development Division is responsible for collecting, archiving and processing large quantities of geological, geochemical, mineral deposit, and surficial geological data for evaluation of the mineral resource potential of the Province. Because of the increase of volume and complexity of these data, sophisticated computer programs are being used in their analysis. All these programs (and data) are presently residing on the AMDAHL V/7 mainframe computer of the Newfoundland and Labrador Computer Centre (NLCS) at Higgins Line. However, to use these programs, one has to be familiar with operating system procedures of the AMDAHL computer, which in themselves are complex.Hence as a result very few geoscientists are able to use these programs to analyze their data themselves.

To overcome this shortcoming, the Computer Unit has decided to shift the emphasis towards development of 'user-friendly' programs on the micro- computers the Division has. The objective of the micro-computer program development is to give research geoscientists the tools to store, analyze and retrieve their data without having to become proficient in computer systems or computer languages. The Computer Unit has two micro-computers:

(i) Tektronix 4054 Graphic System with a plotter.

(ii) Texas Instrument Professional Computer with a 132 column printer.

(i) DEVELOPMENT WORK ON THE TEKTRONIX GRAPHIC SYSTEM

The Tektronix Graphic System consists of:

a) 19" high resolution Graphics Screen

b) 64 K (RAM) memory,

c) a 300 K tape drive cartridge system for storing programs and data;

d) a Hard Copy Unit for photocopying the screen (11" x 8");

e) a 2 pen colour plotter (22" x 17") for plotting camera ready diagrams on mylar.

The Tektronix system uses the BASIC Language so programs written in BASIC only can be used on the system, which is a drawback. The TEKTRONIX 4054 is connected to the AMDAHL computer at Higgins Line enabling the transfer of data to and from the AMDAHL to the TEKTRONIX 4054.

The most widely used program on the TEKTRONIX 4054 is MICRO-GRASP(*). This program provides for the storage, transformation, selection and display of data in tabular form. The user controls the execution of MICRO-GRASP by entering a series of "commands". There are a total of 12 commands which can be used. These commands allow users to enter new data records, establish selection criteria, calculate summary statistics, display selected data values, perform arithmetic operations, review the status of the system, and terminate the session. In addition the user can do graphics work such as plotting Harker variation diagrams and ternary diagrams. These can either be drawn on the screen or can be plotted on the plotter.

(ii) PROPOSED DEVELOPMENT WORK ON THE TEXAS INSTRUMENT PROFESSIONAL COMPUTER

The Computer Unit has recently acquired a 16 bit Texas Instrument Professional Computer System. The system consists of:

i) a 13" color graphics screen;

ii) 320 K RAM memory;

iii) a 320 K disk drive for storing programs and data;

iv) a 5 megabyte Winchester drive for storing programs and data;

v) an operating system which allows the user to run programs written in FORTRAN and BASIC languages;

vi) a 132 column printer.

This micro is also connected to the AMDAHL for the purpose of data transfer. Work is underway to implement MICRO-GRASP on this system, too. In addition the following programs are being evaluated for implementation:

(a) CIPW(*)

This program computes the CIPW norm which expresses the chemical composition of a rock in terms of standard mineral molecules. In addition to CIPW norm, the Thornton & Tuttle Differentiation Index, the Barth's Cations, and Niggli values are computed.

(b) MINRL NORM(*)

This program is used for deriving formulas from chemical analyses of minerals using the anion-based, hydrogen-equivalent method. Input data consist of weight percentage of oxides or halogens and, if desired the density and cell volume of the mineral. From these data the computer calculates the number of ions per molecular formula, normalized values of ions, grain-formula weight, calculated density, and/or calculated cell volume. The program is designed to provide a maximum flexibility of output with a minimum of input data. It eliminates tedious hand calculations, reduces the chances of error, provides a standardized basis of comparison of mineral norms, and permits systematic searches for integral anions per formula or of formulas per unit cell, if these parameters are unknown.

(c) MICROSTAT

Microstat is a commercial statistical program developed by ECOSOFT. Microstat is a library of statistical programs that perform the most common statistical tests and procedures. It was developed for "real life" applications using fairly large data sets. Computation algorithms were selected for accuracy and speed.

More programs will be added to the system depending on the users' needs.

CONCLUSIONS

The MICRO-GRASP system on the Tektronix has been used, over the last six months, by some geologists for manipulating and analyzing data. Experience has shown that after a training period of approximately an hour, a user (geologist) can start using the system to obtain the required information from the data base.

The development of 'user-friendly' programs on the micro-computer will provide another tool for the geologists in their scientific work. A geologist will be able to command a computer system to work for and with him, doing the tedious parts of the work and presenting him with condensed views of his data, allowing him to visualize the information in different ways and encourage a dialogue between the thinking scientist and the functional machine.

(*) These are programs that were developed by:
Roger Bowen of the United States Geological Survey

GEOSCAN - THE NATIONAL DATABASE FOR GEOLOGICAL INFORMATION: 'THE NEWFOUNDLAND CONTRIBUTION'

by

Catherine Patey
Publications and Information Section

GEOSCAN is a computerized bibliographic database of Canadian-produced and/or Canada-related geoscience documents.

The Newfoundland Department of Mines and Energy is one of the ten agencies which index documents for input into this database. Our 'geofiles' and mineral inventory cards are the sources of our indexed documents. Other agencies, e.g. the Geological Survey of Canada and the Earth Physics Branch of the Canada Department of Energy, Mines and Resources, also produce and index documents that concern this province.

In 1982, the National GEOSCAN Centre, which manages GEOSCAN, implemented a new software system, called MINISIS, to input and retrieve the bibliographic data more effectively. Since then, the old and the new systems have been operating concurrently.

The old documents are available in the GEOSCAN Newfoundland and Labrador indexes, current to February 1982, the date of the last update on the old system. These indexes are available from the Publication and Information Section.(See page 27 of the Publications List.)

As well as these products, all of the 67,000 GEOSCAN records from across Canada including those concerning this province are available through on-line computer searches at the Geological Survey of Canada Library in Ottawa and, locally, at our Publications and Information Section. Searches are performed on a cost-recovery basis with a minimal charge of $10.00 per search topic. A moderate size search (100-200 titles) would cost between $15 and $45.

In the implementation of the new system, all these old documents were converted to a new format. For example, different types of keywords were moved into different fields - map types, illustrations, geological terms. Although most of the records did convert, they did not convert cleanly and completely. For example, reports may be missing a title or authors and terms may have been assigned to the wrong fields. Until the National GEOSCAN Centre has completed major modifications of these converted documents, individual agencies cannot do the more detailed modifications such as changing confidential status. In the meantime, we welcome suggestions for improvements and appreciate being notified of any errors or discrepancies that you may discover in the earlier indexes. This would aid in making detailed modifications of the documents.

All new documents are input on the new system and are immediately retrievable on-line. To date, only indexed documents from assessment files have been keyed into the system, although other types of documents, in particular government publications, have been coded.

Besides indexing and keying new documents, new coding sheets are being produced, the authority files or thesauri used in coding are being enlarged, and the terms used are being more clearly defined.

When the new system is fully in place, GEOSCAN should be a much more valuable tool in our search for new mineral resources.

For further information on GEOSCAN, please contact Catherine Patey (709) 737-3159. We look forward to your comments and suggestions.

GEOFILES - MICROFICHE PROJECT

by

N.L. Mercer
Publications and Information Section

GEOFILES - MICROFICHE PROJECT

The Mineral Development Division maintains a geological and mineral resource assessment file system commonly referred to as the "geofiles". The geofiles presently consist of approximately 8,500 geological and geochemical reports, maps, journal articles and mineral assessment files, making them the largest and most comprehensive single collection of geoscience documents about Newfoundland and Labrador.

As a result of the high level of mineral exploration activity experienced during the late 1970's - early 1980's throughout the province, the amount of new data submitted increased substantially. New information is now available on many of the old and also numerous new mineral occurrences in the province. Much more is now known about the geology and mineral potential of various regions both on the island and in Labrador.

The Mineral Development Division of the Newfoundland Department of Mines and Energy has also conducted a large number of field projects over the past few years. This has resulted in the publication of many new geological reports, maps and open files as well as the results of numerous geochemical surveys and surficial and aggregate resource studies.

Mining and exploration companies, prospectors, geotechnical and consultant firms, government agencies, universities, libraries and the general public are continually making use of the geofiles and requesting information from them. Requests have nearly tripled in the past few years.

During the past four years, the Publications and Information Section has been putting all the geofiles on microfiche. This provides a much more efficient system of maintaining the geofiles. Requests for information are processd more rapidly and easily, with relatively inexpensive charges for microfiche.

The Microfiche Project received a serious setback in the fall of 1982 as a result of government restraint measures. Funding for the project was to be terminated effective December 31, 1982. After Rick Soper, our microfiche clerk, resigned to take a position outside government in mid-fall, we were unable to hire a replacement. Since that time, only the most recently submitted mineral assessment reports have been microfilmed, although special requests have continued to be handled. All new Department publications including recent open files are also still being made available on microfiche. However, many of our geofiles, particularly those on Labrador, are not yet available on microfiche. Hopefully, as budget conditions improve, we will be able to rehire staff to continue this important project.

Up to December, 1982, the project involved daily filming of batches of files. The files were cross-checked before filming for quality, content and reproducibility. Two microfiche originals were made and cataloged for each file. Filing follows the standard N.T.S. system presently used in the Department. Duplicates can be copied from the original fiche upon demand. One set of fiche originals is stored offsite at the Torbay Core Library for security and protection from fire.

Project funded by the Newfoundland Department of Mines and Energy.

As of September 1, 1983, microfiche sets of geofiles covering all 1:250,000 N.T.S. blocks in insular Newfoundland are available at a total cost of $1,122. Response to this project so far has been excellent, with a number of mining and exploration companies purchasing all available microfiche sets of geofiles.

In 1983, some work has been done on the Newfoundland General Series of geofiles. Within the next few weeks, sets of microfiche duplicates will be made available for about 250 (of about 1200) geofiles from this series. The release will concern only nonconfidential geofiles that have produced top quality microfiche.

During 1983, we have also begun placing the mineral occurrence reports on microfiche and making them available. Presently, mineral occurrence reports for N.T.S. 2E and 12B are available on microfiche. Those for N.T.S. 14C in Labrador will be available shortly, and further releases will be made as staff in the Mineral Deposits Section complete new N.T.S. areas.

For more information on the microfiche project, please contact Norman Mercer (709) 737-3159. We look forward to your comments and suggestions.

ACKNOWLEDGEMENTS

Rick Soper is thanked for his excellent work on the microfiche project.

The Department of Mines and Energy also acknowledges the continued participation and cooperation of Ches Hapgood and staff of the Micrographics Section, Newfoundland Department of Public Works and Services, especially in filming and duplicating the geofiles.

MINERAL OCCURRENCE DATA SYSTEM

by

C.F. O'Driscoll
Mineral Deposits Section

Introduction

The Mineral Occurrence Data System is designed to offer an efficient information service on all mineral occurrences in Newfoundland and Labrador. It is a two-part project comprising a Mineral Inventory File done on a word processor and a computerized Mineral Index.

Mineral Inventory File

The Mineral Inventory File is part of the National Mineral Inventory and consists of mineral occurrence descriptions which summarize all the available information on known mineral occurrences in the province. A description may be prepared for any type of occurrence from an indication to a producing mine.

To date, information on all mineral occurrences for the island of Newfoundland has been compiled. During 1983, the mineral occurrences for areas 12A, 11O, 11P, 1L and 1M have been completed. In Labrador, areas 23J and 23I have also been completed. These descriptions are now being input and edited and will be available within the next few months. In addition, areas previously done have been updated and the revised descriptions are now available.

Mineral inventory descriptions and 1:50,000 scale location maps are presently being microfiched. Areas which have been completed and are now available are 2E, 12B and 12H on the island, and 13K and 14C in Labrador.

When descriptions are completed for an NTS area, the occurrences are plotted on maps with updated geological bases and then published. Mineral occurrence maps (1:250,000) have been published for NTS areas 12B (Stephenville), 2E (Botwood), and 14C (Nain). In addition, during 1983, maps for the following areas have been published: 13K (Snegamook Lake, 1:250,000), 13K/5 (Wuchusk Lake, 1:50,000), parts of 13J and 13O (Rigolet and Makkovik, 1:100,000). Maps in the following areas have been prepared and will be published within the next year: 1K-1N (Avalon Peninsula), 2C (Bonavista), 2D (Gander Lake), 2F (Wesleyville), 12G (Bay of Islands), 12H (Sandy Lake), 12I (Port Saunders), 12P-2M (Blanc Sablon - St. Anthony) and 13N (Hopedale).

Computerized Mineral Index

The computerized Mineral Index is organized so that a wide variety of complex retrievals can be made which would be virtually impossible if a manual system were used. It contains information selectively extracted from the Mineral Inventory File.

All occurrences compiled before 1983 have been coded and input into the computer. Those occurrences compiled in 1983 are now being coded and will be input within the next year.

Project financed by the Newfoundland Department of Mines and Energy.

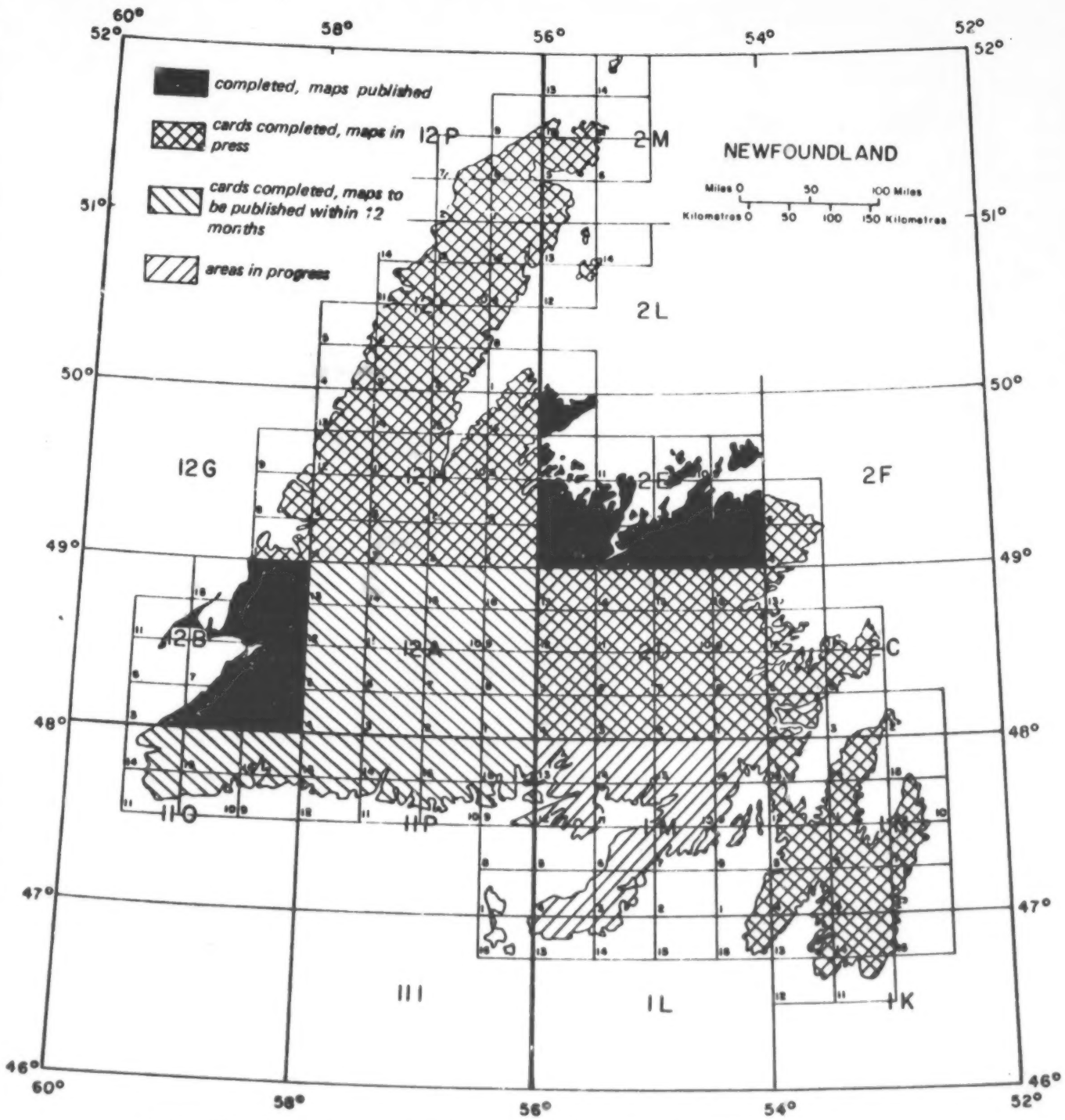

FIGURE 1: *Index map for Mineral Occurrence Data System project, insular Newfoundland.*

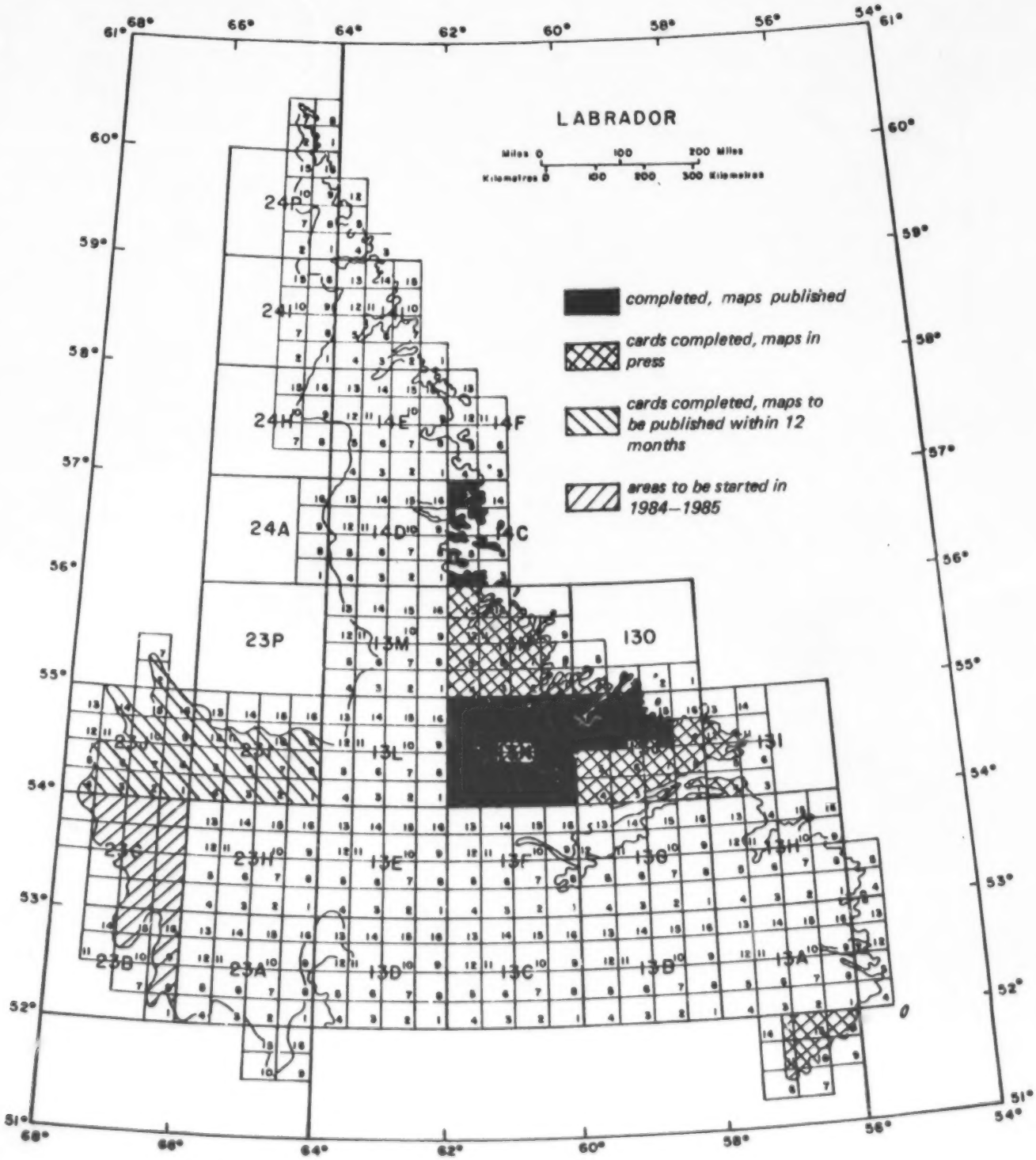

FIGURE 2: *Index map for Mineral Occurrence Data System project, Labrador.*

CORE STORAGE PROGRAM, 1983

by

A. Harris and S. Cochrane
Publications and Information Section

During 1979, the Newfoundland Department of Mines and Energy started a drill core collection and storage program. The primary objective is to provide well maintained and representative collections of drill core from as many drilling programs as possible for the future use of the mineral exploration industry, government geoscientists, university geoscientists and other geotechnical people.

I. Drill Core Collection

During the 1983 field season, drill core collection from abandoned drill sites was completed in Insular Newfoundland and continued in Labrador. In Insular Newfoundland 19,899 m of core were collected from 8 drilling projects and 9,129 m of core were moved from a temporary storage location at Springdale to our core library in Pasadena. Figure 1 shows the locations of all sites from which core has been collected in Insular Newfoundland and Table 1 provides a list of the collected core.

In Labrador 1,252 m of core were collected from 3 drilling sites during 1983. This completed core collection from abandoned drilling sites in the Central Mineral Belt of Labrador. Figure 2 shows the locations of all sites from which core has been collected in Labrador and Table 2 provides a summary of the collected core.

New acquisitions of drill core from Labrador and Insular Newfoundland during 1983 total 21,151 m. To date, the core storage program has collected 141,457 m of drill core.

The Department of Mines and Energy is presently storing some drill core on a confidential, temporary basis. Requests for confidential storage of drill core are treated on an individual basis. Conditions and terms of confidential storage are tied to land status and are similar to the term and conditions of confidentiality which presently apply to assessment reports.

The offering of assessment credits to exploration companies to cover the cost of delivering core to our buildings is presently under consideration.

Section 64 of the Mineral Regulations has been amended to encompass the removal of drill core from the province. The Mineral Regulations regarding drill core now read as shown in Appendix I.

II. Drill Core Libraries

The Department of Mines and Energy now operates three drill core libraries. These libraries are located in St. John's, Pasadena and Goose Bay (Figure 3).

The St. John's core library is fully operational and is staffed on a full-time basis, except during the field season. It has a capacity of 60,000 m of drill core. Approximately 12,000 m of drill core have been cataloged and placed on the rack system to date. Most of this core is from eastern Newfoundland, from the St. Lawrence area and the "silica survey" drilling conducted by the provincial government during the 1960's. Drill hole logs and location maps have been prepared for cataloged core. The St. John's library also contains rock cutting equipment,

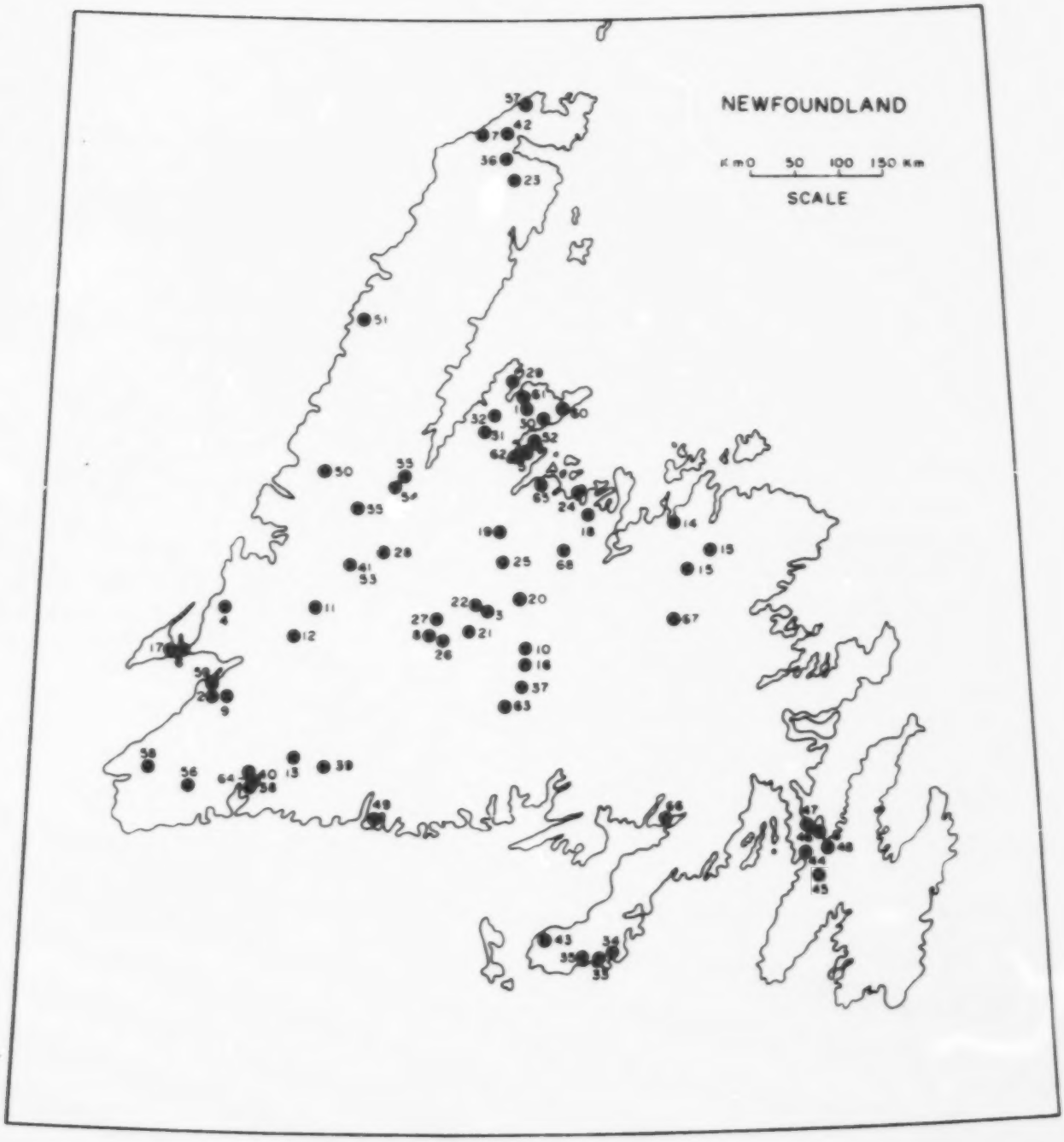

FIGURE 1. CORE COLLECTION SITES
INSULAR NEWFOUNDLAND

FIGURE 2. CORE COLLECTION SITES LABRADOR

Figure 3: *Core libraries in the province of Newfoundland and Labrador.*

core splitters, a stereomicroscope, a magnetic susceptibility meter, a resistivity meter, an ultraviolet light and a McPhar TV-1 scintillometer. These facilities and equipment are available for use on approved projects by exploration geologists, university researchers, the staff of the Department of Mines and Energy and other interested persons.

The Pasadena core library is also fully operational and is staffed on a full-time basis. This library has equipment and facilities similar to the St. John's library and has a capacity of 200,000 m of core. It has a ventilated room for storing radioactive core and a humidity-controlled room for storing salt core. There are approximately 114,000 m of core presently stored in the Pasadena library, collected from drilling sites west of Gander.

The Goose Bay core library is fully operational but is not staffed on a full-time basis. It has a capacity of 60,000 m of core, with room for future expansion. Approximately 6,600 m of core have been cataloged and placed on the rack system to date.

Future Plans

Future plans include cataloging and indexing all drill core collected to date and continuing collection programs, with emphasis on St. John's and Pasadena during the offseason. There is space available in all three libraries for confidential storage of drill core. We encourage explorationists to use our facilities for core storage and related research.

A published drill hole index in booklet form is scheduled for late 1983.

TABLE 1: SUMMARY OF CORE COLLECTED TO DATE - INSULAR NEWFOUNDLAND

No.	Company	Year	Property	# of Holes	Total Metres	Storage Location
1	Advocate	1967	Rambler	2	1,193.0	P
2	Amax	1976	Fischells Area	2	1,420.3	P
3	Amoco	1978	Burnt Pond	4	609.6	P
4	Beth Canada	1978	Springer's Hill	10	911.7	P
5	Boylen-Cerro		Colchester	18	1,379.2	P
6	Canadian Ref.	1970	Aguathuna	13	850.1	P
7	Chevron	1979	Eddies Cove	11	481.6	P
8	Cominco-Hansa	1973(?)	Bobby's Pond	5	431.6	P
9	Hooker Chemical	1968	Fischells	1	173.4	SJ
10	HBOG	1978	Gt. Rattling Bk.	11	818.6	P
11	HBOG	1978	Reid Lot 223	5	306.3	P
12	HBOG	1978	Reid Lot 225	2	117.0	P
13	HBOG	1978	Top Pond	1	47.1	P
14	Internat. Mogul	1974	Campbellton Area	15	1,394.5	P
15	Internat. Mogul	1975	Gander Area	12	708.7	P
16	Minorex	1978	Atlantic Lake	6	439.5	P
17	Nfld. Mines Br.		Port au Port	?	811.5	P
18	Noranda	1972	Point Leamington	3	265.8	P
19	Noranda	1973	Gullbridge	1	54.9	P
20	Noranda	1975	Leonard's Lake	3	388.6	P
21	Noranda	1975-78	Tally Pond	2	489.2	P
22	Noranda	1978	Burnt Pond	2	165.0	P
08	Noranda	1978	Bobby's Pond	4	320.6	P
23	Shell Can. Res.	1975-76	Main Brook Area	32	1,859.3	P
24	Texas Gulf	1975	Seal Bay	8	1,104.9	P
19	Gullbridge Mines	?	Gullbridge	213	12,473.9	P
25	Consol. Morr.	1976	Lake Bond	2	419.1	P
26	L.M. & E.	?	Lake Ambrose	6	647.7	SJ
27	Kerr Addison	1974-75	Victoria Area	5	655.3	P
28	Shawmont	1977-78	Hinds Brook	28	822.9	P
29	Advocate	?	Priests Showing	8	774.8	P
30	Advocate	?	Nippers Harbour	7	946.1	P
31	Advocate	1976	West Pond	3	144.7	P
32	Advocate	1975	Flatwater Pond	11	907.6	P
33	ALCAN	?	St. Lawrence	?	8,153.4	SJ
34	D.S. Robertson	?	Mt. Margaret Area	?	4,463.8	SJ
35	D.S. Robertson	?	Lawn Area	?		SJ
36	Noranda	?	Round Pond Area	?	?	P
37	RIOCANEX	1976	Cold Spring Pond	1	30.0	SJ
38	Falconbridge		Strickland Property	?	4,427.2	P
39	Falconbridge	1981	Burgeo Road	16	1,059.2	P
40	Long Lac Min.	1968	Strickland Property	18	975.3	P
41	Minorex	1978-80	Deer Lake	25	1,993.3	P
42	U.S. Borax	1979	Hidden Pond	11	237.6	P
43	Nfld. Mines Branch	1960's	Fortune (Silica)	3	199.9	SJ
44	Nfld. Mines Branch	1960's	Long Harbour (Silica)	6	232.5	SJ
45	Nfld. Mines Branch	1960's	Argentia (Silica)	11	731.6	SJ

TABLE 1: (Cont'd)

No.	Company	Year	Prop	# of Holes	Total Metres	Storage Location
46	Nfld. Mines Branch	1960's	Thornlea (Silica)	6	230.9	SJ
47	Nfld. Mines Branch	1960's	Bellevue (Silica)	7	187.1	SJ
48	Nfld. Mines Branch	1960's	Long Cove (Silica)	4	164.1	SJ
49	Nfld. Mines Branch	1960's	Grey River (Silica)	6	256.2	SJ
50	Nfld. Mines Branch	1960's	Bonne Bay (Silica)	4	197.2	SJ
51	U.S. Borax	1981	Daniels Harbour	2	804.6	P
52	Minorex	1981	Silverdale	7	203.6	P
53	Minorex	1979-80	Deer Lake	?	109.7	P
54+	Westfield Minerals	1978-81	Deer Lake	130	8,314.9	P
55+	Northgate Expl.	1979	Deer Lake	16	2,511.5	P
56	Riocanex	1978-81	Cape Ray	171	20,461.0	P
57	Essex	1981	Watts Bight	4	609.6	P
58	Shell Can. Res.	1980	Codroy Valley	6	890.0	P
59+	Flintkote	1979-80	Flat Bay	?	3,214.0	P
60+	Newmont	1981	Tilt Cove	6	864.1	P
61+	Rambler Mines	?	Ming Mine	64	19,150.0	P
62	BRINEX	?	Whalesback	235	12,226.0	P
63	Riocanex	1976	Great Burnt Lake	9	1,463.0	P
64	St. Joe Can.	1982	Big Pond	9	707.0	P
65	Billiton	1981	Ghost Pond	3	668.0	P
66+	Esso Minerals	1982	Ackley Granite	5	280.0	SJ
67	HBOG	1980	Gander Lake South	7	296.1	P
68	HBOG	1980	New Bay Pond	6	356.8	P
				Total	131,203.3	

Key

P - Pasadena Core Library
SJ - St. John's Core Library
+ - Temporary Confidential Storage

TABLE 2: SUMMARY OF CORE COLLECTED TO DATE - LABRADOR

No.	Company	Year	Property	# of Holes	Total Metres	Storage Location
1	American Metal Co.	1954	Green Pond	3	16.7	GB
2	Brinex	1972	Seal Lake	19	1,333.5	GB
3	Canadian Nickel Co.	1978-80	Moran Lake	30	2,103.1	GB
4	Mokta Can. Ltd.	1965	Moran Lake	8	220.9	GB
5	Northgate Explor. Ltd.	1980	Lake Melville	8	652.2	GB
6	Placer Devel. Ltd.	1980-81	Banana Lake	11	655.3	GB
7	Riocanex	1961	Ten Mile Lake	4	197.5	P
8	Shell Can. Res.	1977-79	Moran Lake	61	3,822.2	GB
9	Shell Can. Res.	1977	Sylvia Lake	3	99.4	GB
10	Shell Can. Res.	1977	Madsen Lake	2	114.8	GB
11	Nfld. and Lab. Hydro	?	Gull Island		1,037.8	GB
				Total	10,253.4 m	

Key

GB - Goose Bay Library
P - Pasadena Library

APPENDIX I

MINERAL REGULATIONS RE: DRILL CORE

Preservation of Diamond Drill Core

64. No person, whether a holder of mineral rights issued under this Act or these Regulations or not, shall intentionally abandon, discard, dump, destroy or otherwise reduce the original technical value of any diamond drill core or rotary drill cuttings obtained for information purposes within the Province or remove same from the Province, except for those sections submitted for assaying, testing, microscopic, metallurgical and beneficiation studies, without the permission of the Minister.

Minister May Allow Disposal or Obtain Core for Crown

65.--(1) All persons proposing to dispose of any diamond drill core in their possession or lodged with them for safekeeping, shall notify the Minister of their desire to do so and upon receipt of such notification the Minister

(a) shall provide such persons with permission in accordance with regulation 64 or

(b) may direct his authorized representative to take possession of such drill core for the Crown and take such other action as he may deem necessary.

(2) The actions directed by the Minister under paragraph (1) shall be undertaken at the expense of the Crown.

PROJECT REPORT OF THE GEOCHEMICAL LABORATORY FOR 1983

by

H.A. Wagenbauer
Geochemistry Section

The analytical facilities of the laboratory remain as described in Wagenbauer et al. (1983). No new equipment has been acquired, but the staff level was reduced from eleven to six full-time employees. Consequently, it has not been possible to carry out any significant amount of methods development, and the range of analyses performed is unchanged from that described in Wagenbauer et al. (1983). The work done between September 1, 1982 and August 31, 1983 is summarized in Table 1. The total number of determinations is down by 16% from the previous year. This drop in output reflects the cuts in staff and budget.

Table 1: *Summary of output from the geochemical laboratory of the Mineral Development Division from Sept. 1, 1982 to August 31, 1983 compared with the previous 12 month period.*

Type of determination	Number of determinations 81/82	82/83
Geochemical analysis of soil, till, and stream and lake sediments	40,641	42,188
Silicate analyses		
Trace elements	22,205	7,721
Major elements	28,967	28,993
Miscellaneous analyses		
(Assays, F, Sn, W, Ba, Sr, pH on a variety of sample types)	11,768	8,496
	103,581	87,398

References

Wagenbauer, H.A., Riley, C.A., and Dawe, G. 1983. Geochemical Laboratory. *In* Current Research. *Edited by* M.J. Murray, P.D. Saunders, W.D. Boyce, and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 133-137.